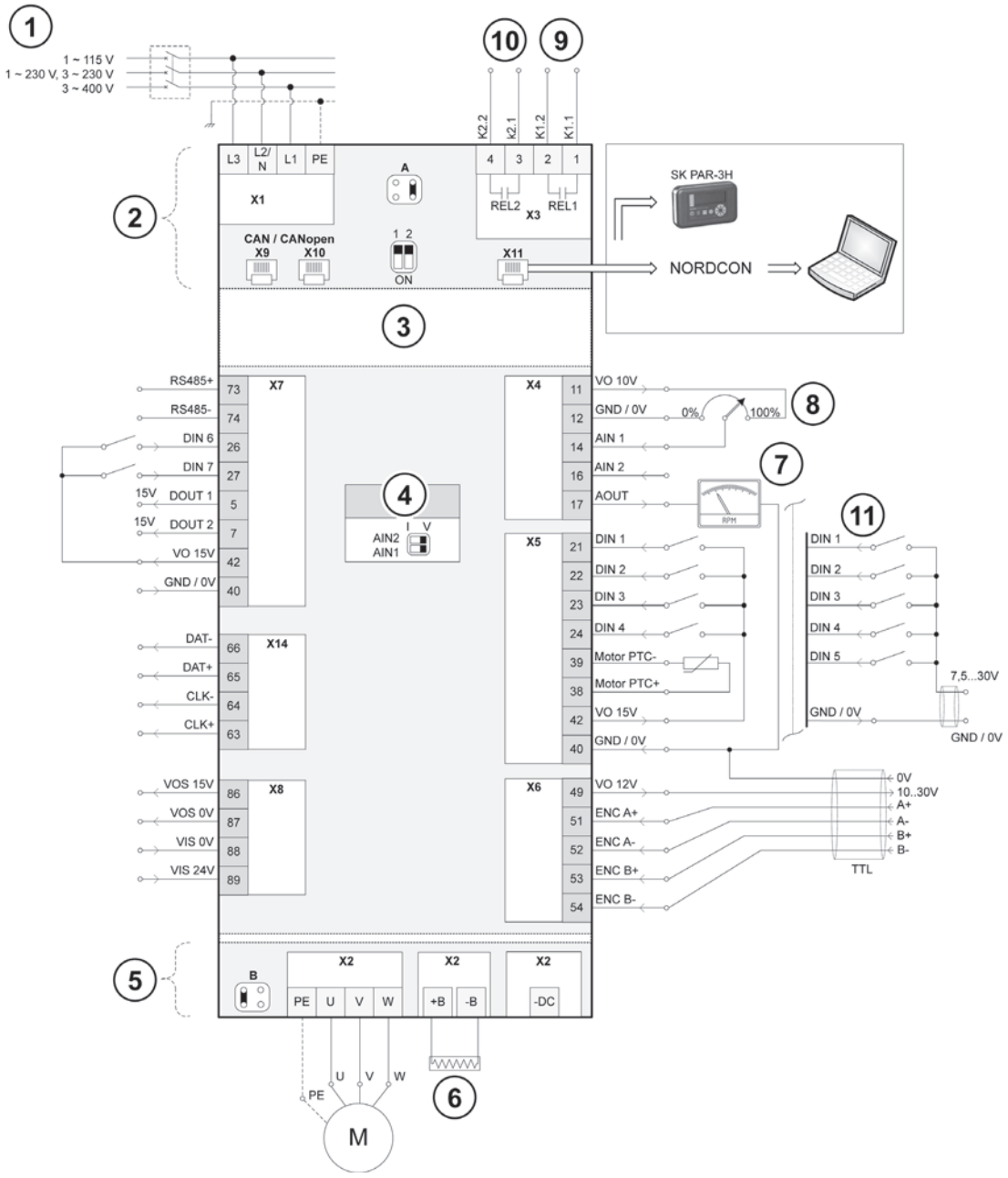
BU 0505 – en

NORDAC *PRO* (SK 540E series)

Manual with installation instructions

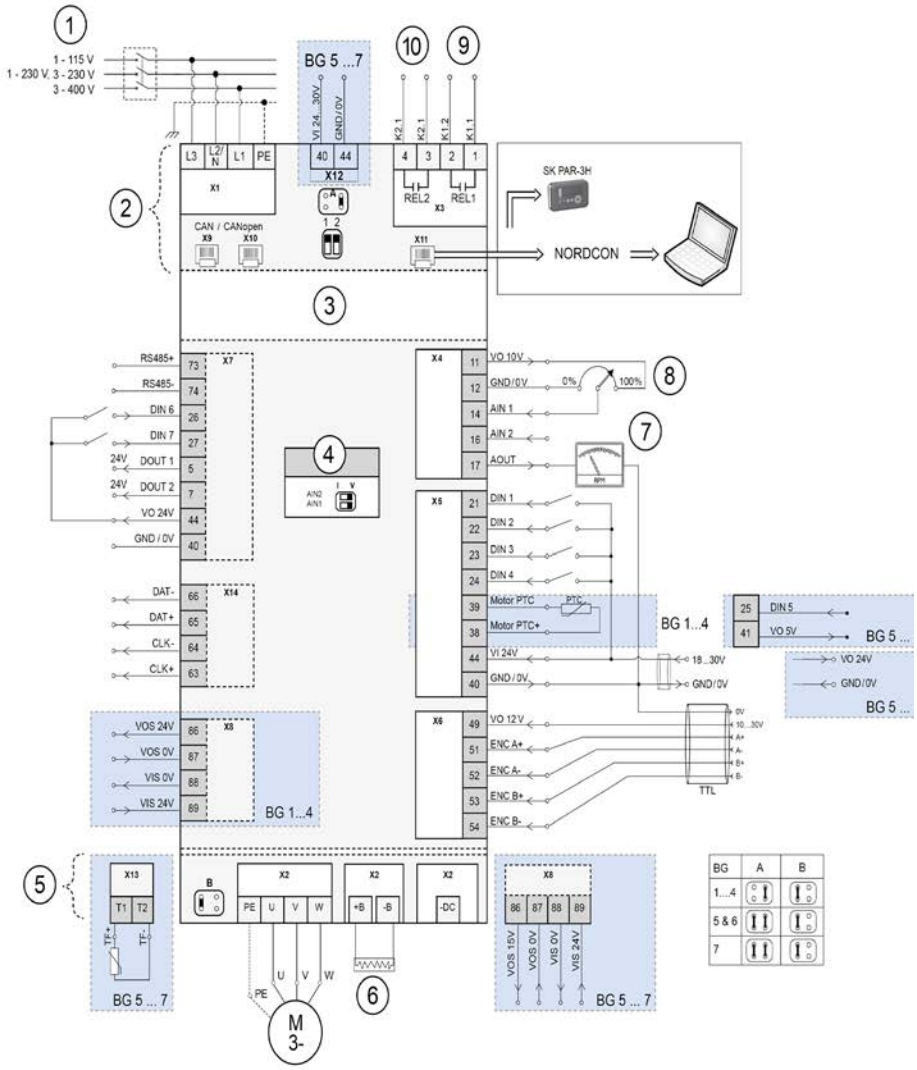
SK 540E: Sizes 1 … 4



1	Power supply suitable for device (see Technical Data)	8	Setpoint (speed)
2	Top view	9	Connection for an electromechanical brake
3	Slot for a technology unit (SK TU3-…)	10	Connection message “Inverter ready”
4	Configuration of analogue inputs	11	Alternative example “Digital input power supply via external power source (24 V DC)”
5	Bottom view	M	Motor
6	Optional braking resistor	Size	Size
7	Actual value (speed)	X8	Not suitable for devices with a nominal voltage of 1 ~ 115 V

Important: Please note the detailed description of the control terminals in the manual.

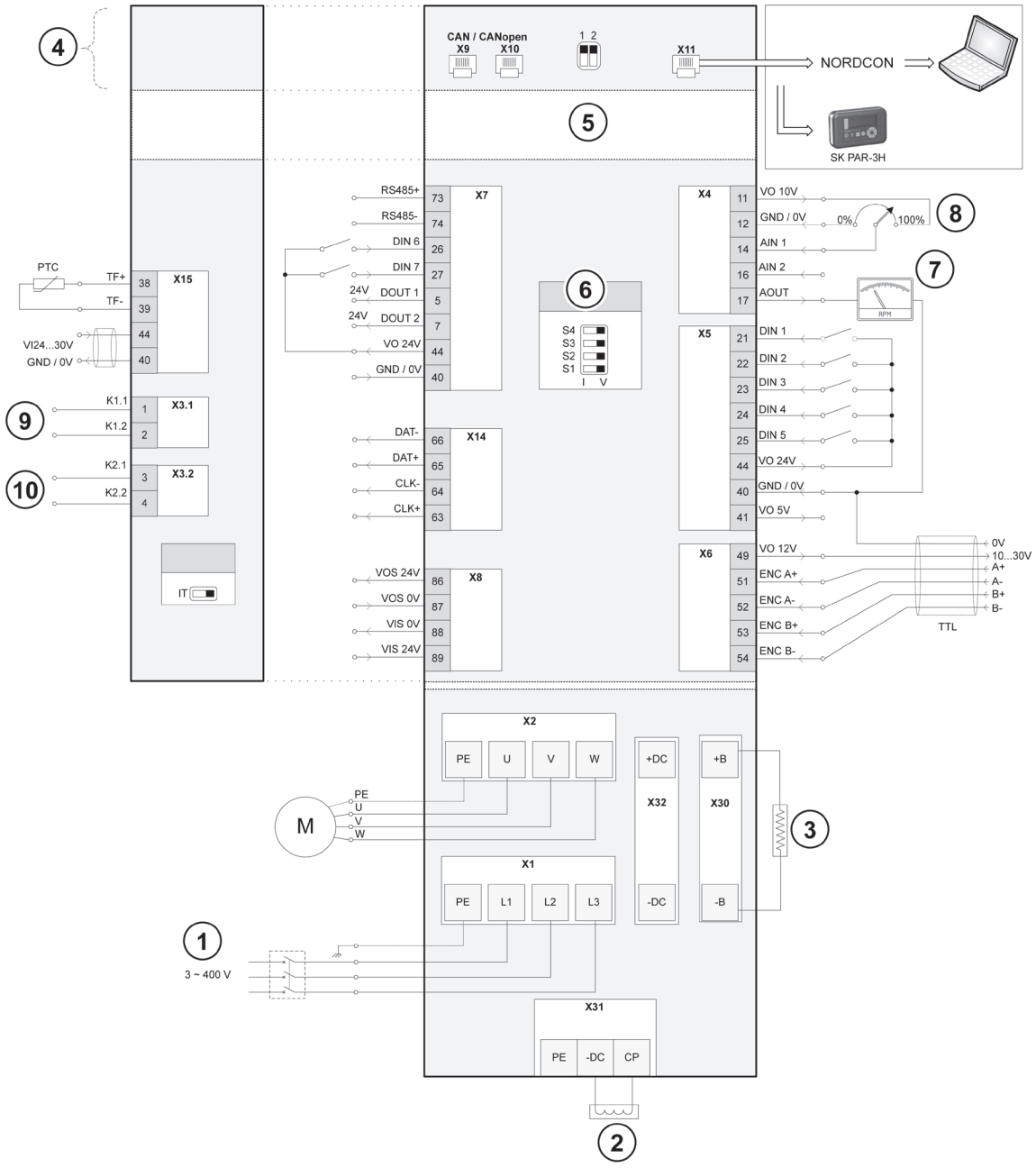
SK 545E: Sizes 1 … 7



1	Voltage supply suitable for the device (see technical data)	8	Setpoint (speed)
2	Top view	9	Electromechanical brake connection
3	Slot for a technology unit (SK TU3-…)	10	Connection message “Inverter ready”
4	Analogue input configuration	M	Motor
5	Bottom view	BG	Size
6	Optional braking resistor	X8	Sizes 1 … 4: Not suitable for devices with a nominal voltage of 1~ 115 V
7	Actual value (speed)		

Important: Please note the detailed description of the control terminals in the manual.

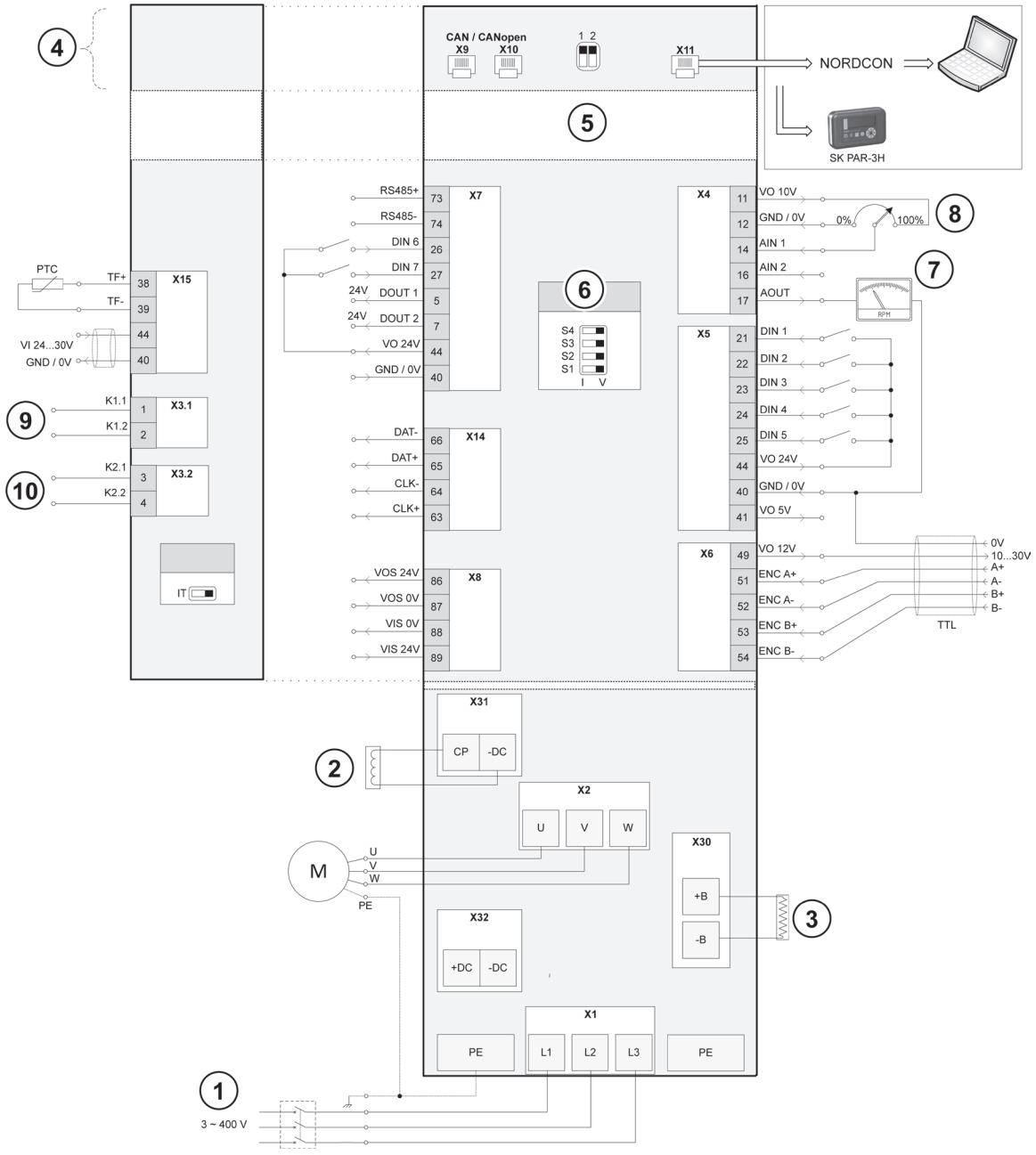
SK 545E: Sizes 8 and 9



1	Voltage supply suitable for the device (see technical data)	7	Actual value (speed)
2	Link circuit choke: recommended for size 8 and higher	8	Setpoint (speed)
3	Optional braking resistor	9	Electromechanical brake connection
4	Top view	10	Connection message “Inverter ready”
5	Slot for a SK TU3-… technology unit	M	Motor
6	Analogue input configuration	BG	Size

Important: Please note the detailed description of the control terminals in the manual.

SK 545E: Sizes 10 and 11



1	Voltage supply suitable for the device (see technical data)	7	Actual value (speed)
2	Link circuit choke: recommended for size 8 and higher	8	Setpoint (speed)
3	Optional braking resistor	9	Electromechanical brake connection
4	Top view	10	Connection message “Inverter ready”
5	Slot for a SK TU3-… technology unit	M	Motor
6	Analogue input configuration	BG	Size

Important: Please note the detailed description of the control terminals in the manual.

Read document and keep for future reference

Read this document carefully prior to performing any work on or putting the device into operation. It is essential to read and observe the instructions in this document. They serve as the prerequisite for smooth and safe operation and the fulfilment of any warranty claims.

Contact Getriebebau NORD GmbH & Co. KG if your questions regarding the handling of the device are not answered in this document or if you require further information.

The German version of this document is the original. The German document is always decisive. If this document is available in other languages, this will be a translation of the original document.

Keep this document in the vicinity of the device so that it is available if required.

Use the version of this documentation that is valid for your device at the time of delivery. You can find the currently valid version of the documentation under www.nord.com.

Please also note the following documents:

- Catalogue “NORDAC electronic drive technology” (E3000),
- Documentation for optional accessories
- Documentation for equipment which is attached or provided.

Please contact Getriebebau NORD GmbH & Co. KG if you require further information.

Documentation

Designation:	**BU 0505**	
Part no.:	**6075052**	
Series:	SK 500E	
Device series:	SK 540E, SK 545E	
Device types:	SK 5xxE-250-112- ... SK 5xxE-750-112-	(0.25–0.75 kW, 1~ 115 V, output: 3~ 230 V)
	SK 5xxE-250-323- ... SK 5xxE-221-323-	(0.25–2.2 kW, 1/3~ 230 V, output: 3~ 230 V)
	SK 5xxE-301-323- ... SK 5xxE-182-323-	(3.0–18.5 kW, 3~ 230 V, output: 3~ 230 V)
	SK 5xxE-550-340- ... SK 5xxE-163-340-	(0.55–160.0 kW, 3~ 400 V, output: 3~ 400 V)

Version list

Title, date	Order number	Device firmware version	Remarks
BU 0505, March 2013	**6075052** / 1013	V 2.0 R5	First issue.
More revisions: February 2015 (For an overview on the changes made to the above-mentioned issue, see issue from February 2015 (part no.: **6075052**/0715))			

Title, date	Order number	Device firmware version	Remarks
BU 0505, April 2016	**6075052** /1516	V 2.3 R0	Among others: • General corrections • Adaptation of parameters: P220, 241, 244, 312, 315, 334, 504, 513, 520, 748 • Error messages I000.8 and I000.9 added • Revision of “Standards and approvals” chapter • Revision of “UL/cUL” chapter – *For CSA:* Voltage limitation filter no longer required (SK CIF) → Module removed from document – *Sizes 10 and 11:* “In preparation” note removed, adaptation of fuses • Revision of “Technical / electrical data”, sizes 10 and 11: Adaptation of fuses (types and sizes) • Update of EC/EU declaration of conformity • Revision of “Cold plate technology framework conditions” chapter
BU 0505, July 2021	**6075052** / 3021	V 2.3 R0	• Update of “Standards and approvals” • Update of EU declaration of conformity • Supplementation of data according to the Ecodesign Directive
BU 0505, March 2024	**6075052** / 1024	V 2.5 R0	Among others: • General corrections • Supplementation of terminal diagrams • Restructuring of safety information • Removal of information on connection to an input and feedback unit • Adaptation of temperature sensors section • Adaptation of parameters: P200, P241, P244, P245, P327, P328, P330, P334, P462, P504, P558 • Addition of parameters: P336, P351, P353, P355, P356, P360, P370, P583 • Error messages E7.1, E16.2, E19.2 added • “Motor data – characteristic curves” added • Standardisation of setpoints and actual values corrected • Revision of maintenance and service notes • Supplementation of disposal notes • No UL/CSA certification for devices with a nominal power of 110 kW and higher and with hardware status “ABA”

Table 1: Version list

Copyright notice

Publisher

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1 General

The devices have sensorless current vector control with a wide range of settings. In combination with suitable motor models, which always provide an optimised voltage/frequency ratio, all three-phase asynchronous motors that are suitable for inverter operation and permanently excited synchronous motors can be driven. For the drive, this means very high starting and overload torques at a constant speed.

The power range is from 0.25 kW to 160.0 kW.

The device series can be adapted to individual requirements by means of modular assemblies.

This manual is based on the device software as stated in the version list (see P707). If the frequency inverter uses a different software version, this may cause differences. If necessary, the current manual can be downloaded from the Internet (http://www.nord.com/).

Additional descriptions exist for optional functions and bus systems (http://www.nord.com/).

Information

Accessories

The accessories that are mentioned in the manual are also subject to changes. Current details of these are included in separate data sheets, which are listed under www.nord.com under the heading *Documentation → Manuals → Electronic drive technology → Techn. info / Data sheet*. The data sheets available at the date of publication of this manual are listed by name in the relevant sections (TI ...).

As standard, the frequency inverters are equipped with a fixed heat sink, via which the power losses are dissipated to the environment. Alternatively, for sizes 1 - 4 there is the ColdPlate version and for sizes 1 and 2 there is also an external heat sink version.

As standard, inverters for 230V or 400V operating voltage are supplied with an integrated mains filter. However, versions without a mains filter are available for frequency inverters above Size 7. Frequency inverters for 115V operating voltage are normally supplied without mains filters.

1.1 Overview

Features of the basic device **SK 500E**:

- High starting torque and precise motor speed control by means of sensorless current vector control
- Can be mounted next to each other without additional spacing
- Permissible ambient temperature: 0 to 50 °C (refer to technical data)
- SK 5xxE … **-A** devices: Integrated **EMC line filter** for limit values of class A1 (and B for devices of sizes 1 … 4) according to EN 55011, category C2 (and C1 for devices of sizes 1 … 4) according to EN 61800-3 (not for 115 V devices)
- SK 5xxE … **-O** devices: ***without*** Integrated **EMC line filter**.
- Automatic measurement of the stator resistance or determination of the exact motor data
- Programmable direct current braking
- Installed brake chopper for 4-quadrant operation (optional braking resistors)
- Four separate, online-switchable parameter sets
- RS232/485 interface via RJ12 plug
- USS and Modbus RTU-integrated (see BU 0050)

Feature / SK …	50xE	51xE	511E	520E	53xE	54xE	Additional information
Manual	BU 0500					BU 0505	
Safe pulse block (STO/SS1)*		x	x		x	x	BU 0530
2x CANbus/CANopen interface via RJ45 plug			x	x	x	x	BU 0060
Additional RS485 interface on the terminal strip				x	x	x	
Speed feedback via incremental encoder input				x	x	x	
Integrated POSICON positioning control					x	x	BU 0510
CANopen absolute encoder evaluation					x	x	BU 0510
PLC functionality				x	x	x	BU 0550
Universal encoder interface (SSI, BISS, Hiperface, EnDat and SIN/COS)						x	BU 0510
Operation of PMSM (**P**ermanent **M**agnet **S**ynchronous **M**otor)	x	x	x	x	x	x	
Number of digital inputs/outputs**	5/ 0	5/ 0	5/ 0	7/ 2	7/ 2	5/ 3 6/ 2 7/ 1	
Additional, electrically isolated PTC resistor***						x	
Number of analogue inputs/outputs	2/ 1	2/ 1	2/ 1	2/ 1	2/ 1	2/ 1	
Number of relay signals	2	2	2	2	2	2	

*Not for 115 V devices
**SK 54xE: Two I/Os that are variably parameterisable as input or output
***Alternatively: “PTC resistor” function available on digital output 5 (additional PTC resistor input is generally available for size 5 and higher)

Table 2: Overview of SK 500E performance level properties

Deviating hardware properties

Version	Description
SK 5xxE-…-CP in comparison to SK 5xxE	• Cold plate or external heat sink technology
SK 5x5E in comparison to SK 5x0E	• External 24 V supply voltage – communication with the device is also possible without power connection
Size 5 and higher (> 4 kW, 230 V or > 11 kW, 400 V) in comparison to sizes 1–4	• Additional PTC input (electrically isolated) that is installed separately • External 24 V supply voltage with automatic switching to internal 24 V extra-low voltage generation in case of failure of the external control voltage • Bipolar analogue signals can also be processed • In general: 2x CANbus/CANopen interface via RJ45 plug
Size 7 and higher (≥ 30 kW), in comparison to sizes 1–6	• Water-repellent coating of electronic components (to increase operational reliability in case of condensation.) [1)]

1) Optionally available for devices of sizes 1–6; available as standard for size 7 and higher

Table 3: Overview of deviating hardware properties

1.2 SK 5xxE with or without integrated line filter

The device series (SK 500E … SK 545E) is available in two different versions:

1. SK 5xxE-…**-A** devices are factory-fitted **with an integrated EMC line filter**. The EMC line filter is located at the mains input and meets the specifications of the European EMC Directive 2004/108/EC (granting of the CE mark).
2. SK 5xxE-…**-O** devices have **no** integrated **EMC line filter**.

1.2.1 Operation of an SK 5xxE-…-A device

If a **mains choke** is implemented upstream of the frequency inverter, a resonant circuit results from the mains impedance, the mains choke and the X2 capacitors of the internal EMC line filter.

This resonant circuit is excited by harmonics in the mains voltage or by every switching on the mains. Due to typically high damping, however, this does not result in permanent oscillations with increasing amplitudes.

Parallel connection of devices to the supply network, which either permanently or temporarily generate harmonics on the mains voltage in the frequency range stated above – for example power factor correction units or wind power stations – may lead to stronger excitation of the resonant circuit, causing an increase of the harmonics voltage, which is added to the mains voltage.

Consequence:

- Overload up to total failure of the X2 capacitors
- Impermissible charging of the link circuit with error messages up to exceeding the permissible DC link voltage with total failure

Permanent damage to the frequency inverter is possible in both cases.

Information

Devices with 45 kW and higher (sizes 8 … 11)

For devices of sizes 8 … 11, **link circuit chokes** are available, which are used instead of a mains choke. In the resonant circuit described above, the inductance of the mains choke is omitted, causing the resulting resonance frequencies to be within the non-critical high frequency range.

1.2.2 Operation of an SK 5xxE-…-O device

The SK 5xxE-xxx-340-O series no longer has the EMC line filter and only features reduced X2 capacitors for basic interference suppression at the mains input. In the “-O” frequency inverters, filtering on the mains side is reduced to an absolute minimum, resulting in resonance frequencies above the frequency inverter’s maximum permissible pulse frequency (16 kHz) when using a mains choke.

In this significantly higher frequency range, sufficient damping can be assumed, so that the resonance phenomena with the consequences described above can no longer be expected.

In order to comply with EMC requirements with these devices as well, suitable footprint filters are available (see chapter 8.3 "Electromagnetic compatibility (EMC)"), (see chapter 2.8 "Line filter").

1.2.3 When to use which device?

In general, a device with integrated EMC line filter (...-A) should be preferred, as this device meets the requirements of the EMC Directive. An “...-O” device should be used under certain conditions.

In particular with critical (harmonic) mains supplies or when using a mains choke (SK CI1-…), an “…-O” device should be used.

How to detect critical mains supplies

a. Increased DC link voltages in standby mode or even overvoltage error messages indicate resonance phenomena. The currently present voltages can be controlled and checked for

plausibility via the frequency inverter's information parameters (**P728** "*Input Voltage/Line voltage*", **P736** "*D.c. link voltage*" and **P751** "*Stat. Overvoltage/Count of error message E005*").

b. In the network, there have already been frequency inverter failures with damage to link circuit capacitors or the EMC line filter circuits.
c. Sliding contacts on conductor rails can lead to short-term voltage interruptions (for example transfer cars in high-bay warehouses).

1.3 Delivery

Examine the device for transport damage or loose components **immediately** on delivery / unpacking.

In case of damage, contact the carrier immediately and arrange for a careful survey.

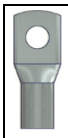
Important! This also applies if the packaging is undamaged.

1.4 Scope of delivery

Standard version:

- IP20
- Integrated brake chopper
- Certonal-coated PCB (size 7 and higher)
- Integrated EMC line filter for limit curve A1 or category C2 (only SK 5xxE-…**-A** devices)
- Blank cover for technology unit slot
- Shielding clamp for control terminals
- Cover for the control terminals
- Sizes 1–7: Accessory bag with wall-mounting brackets
- Size 8 and higher: Accessory bag with electrical connection material
- Screw (2.9 mm x 9.5 mm) to fasten the blank cover or an optional SK TU3-… technology unit
- Operating instructions on CD

Content of accessory bag for size 8 and higher:

	Size 8	Size 9	Size 10	Size 11	
				160 kW	200 kW
	Tubular fork terminal 50 mm² M8, straight 8 pieces (L1, L2, L3, U, V, W, +B, -B)	Tubular fork terminal 95 mm² M8, straight 8 pieces (L1, L2, L3, U, V, W, +B, -B)	Tubular fork terminal 120 mm² M8, straight 8 pieces (L1, L2, L3, U, V, W, +B, -B)	Tubular fork terminal 150 mm² M10, straight 8 pieces (L1, L2, L3, U, V, W, +B, -B)	Tubular fork terminal 185 mm² M10, straight 8 pieces (L1, L2, L3, U, V, W, CP, -DC)
	Tubular fork terminal 35 mm² M8, straight 3 pieces (PE)	Tubular fork terminal 50 mm² M8, straight 3 pieces (PE)	Tubular fork terminal 95 mm² M8, straight 3 pieces (PE)	Tubular fork terminal 120 mm² M8, straight 3 pieces (PE)	Tubular fork terminal 150 mm² M10, straight 3 pieces (PE)
	–	–	–	–	Tubular fork terminal 120 mm² M8, straight 3 pieces
	DIN 6796 conical spring washer 8 11 pieces	DIN 6796 conical spring washer 8 11 pieces	–	–	–
	Disc/washer DIN 934 M8 11 pieces	Disc/washer DIN 934 M8 11 pieces	–	–	–
	Self-tapping screw 2.9 X 9.5 DIN 7981 GAL.ZN 1 piece	Self-tapping screw 2.9 X 9.5 DIN 7981 GAL.ZN 1 piece	Self-tapping screw 2.9 X 9.5 DIN 7981 GAL.ZN 1 piece	Self-tapping screw 2.9 X 9.5 DIN 7981 GAL.ZN 1 piece	Self-tapping screw 2.9 X 9.5 DIN 7981 GAL.ZN 1 piece
	Heat shrink D25.4/D12.7 L = 400 mm 1 piece	Heat shrink D25.4/D12.7 L = 400 mm 1 piece	Heat shrink D25.4/D12.7‘ L = 700 mm 1 piece	Heat shrink D25.4/D12.7 L = 1 m 1 piece	Heat shrink D25.4/D12.7 L = 1 m 1 piece
	–	–	–	–	Washer DC-CHOKE 5 pieces

Available accessories:

	Designation	Example	Description
Control and parametrisation options	**Technology units for mounting to the device**		For commissioning, parametrisation and control of the device **Types: SK TU3-CTR, SK TU3-PAR, SK CSX-0** (see chapter 3.2 "Technology units overview")
	Technology units for installation in the control cabinet		For commissioning, parametrisation and control of the device **Types: SK CSX-3E, SK PAR-3E** (see chapter 3.2 "Technology units overview")
	Handheld control boxes		For controlling the device **Type: SK POT- …** See BU 0040
	NORDCON **MS Windows®-based software**		For commissioning, parametrisation and control of the device See www.nord.com NORDCON

Designation		Example	Description
Bus interfaces			Technology units to be snapped onto the device for: AS-Interface, CANopen, DeviceNet, InterBus, Profibus DP, EtherCat, EtherNet/IP, Profinet IO, Powerlink **Type: SK TU3- …** (see chapter 3.2 "Technology units overview")
Braking resistor	**Chassis braking resistor**		Dissipation of generator-based energy from the drive system by conversion into heat. Generator-based energy energy is generated during braking processes. **Type: SK BR2- …** (see chapter 2.6 "Braking resistor (BR)")
	Footprint braking resistor		See *Chassis braking resistor* **Type: SK BR4- …** (see chapter 2.6 "Braking resistor (BR)")
Choke	**Motor choke**		Reduction of interference (EMC) from the motor cable, compensation of cable capacitances **Type: SK CO1- …** (see chapter 2.7.2 "Output choke SK CO1")
	Mains choke		Reduction of mains-induced current harmonic contents and charging currents **Type: SK CI1- …** (see chapter 2.7.1.2 "SK CI1 mains choke")
	Link circuit choke		Reduction of mains-induced voltage distortions and current harmonic contents **Type: SK DCL- …** (see chapter 2.7.1.1 "Link circuit choke SK DCL-")

Designation		Example	Description
Line filter	**Chassis line filter**		Reduction of interference (EMC) **Type: SK HLD …** (see chapter 2.8.3 "SK HLD line filter")
	Footprint line filter		Reduction of interference (EMC) **Type: SK LF2 …** (see chapter 2.8.2 "SK LF2 line filter (sizes 5–7)")
	Footprint combined filter		Reduction of interference (EMC) and compensation of cable capacitances **Type: SK NHD …** (see chapter 2.8.1 "Mains filter SK NHD (up to size 4)")
Assembly variants	**Top-hat rail assembly set**		Set for device assembly on a TS35 DIN rail (EN 50022) **Type: SK DRK1- …** (see chapter 2.4 "Snap-on mounting rail kit SK DRK1-…")
	External heat sink kit		Heat sink set for mounting on a device in cold plate design (SK 5xxE…-CP). This allows to directly dissipate the device's waste heat from the control cabinet. **Type: SK TH1- …** (see chapter 2.3 "External heat sink kit")

Designation	Example	Description
EMC kit		Shield bracket for EMC-compliant connection of shielded cables **Type: SK EMC2- …** (see chapter 2.5 "EMC Kit")
Electronic brake rectifier		Direct control of electromechanical brakes **Type: SK EBGR-1** See link
IO extension		External IO extension (analogue and digital) **Type: SK EBIOE-2** See link
Interface converter		Signal converter: RS232 → RS485 **Type: SK IC1-232/485** See link
Setpoint converter ± 10 V		Signal converter from bipolar to unipolar analogue signals (only for FIs of sizes 1–4) **Type: setpoint converter ± 10 V** See link
V/F converter adapter module		Signal converter for conversion of a potentiometer's 0 ... 10 V analogue signals into pulse signals for evaluation at the frequency inverter's digital input (SK 500E … SK 535E) **Type: V/F converter adapter module** See link
V/I converter adapter module		Signal converter for conversion of 0 ... 10 V analogue signals into 0 ... 20 mA signals, for example for evaluation on a PLC with current signal input **Type: V/I converter adapter module** See link
RJ45 adapter module		Adapter for single-wire signal cables to RJ45 **Type: WAGO Ethernet adapter module with CAGE CLAMP connection** (see chapter 2.10 "RJ45 WAGO- Connection module")

Software (Free download)	**NORDCON** **MS Windows ®-based software**		For commissioning, parametrisation and control of the device. See www.nord.com NORDCON
	ePlan macros		Macros for producing electrical circuit diagrams See www.nord.com ePlan
	Device master data		Device master data/device description files for NORD field bus options NORD field bus files
	S7 standard modules for PROFIBUS DP and PROFINET IO		Standard modules for NORD frequency inverters See www.nord.com S7_Files_NORD
	Standard modules for the TIA portal for PROFIBUS DP and PROFINET IO		Standard modules for NORD frequency inverters *Available on request.*

1.5 Safety, installation and application information

Before working on or with the device, please read the following safety instructions extremely carefully. Please pay attention to all other information from the device manual.

Non-compliance can result in serious or fatal injuries and damage to the device or its surroundings.

These safety instructions must be kept in a safe place!

1. General

Do not use defective devices or devices with defective or damaged housings or missing covers. Otherwise, there is a risk of serious injury or death from electric shock or rupture of electrical components, e.g. high power capacitors.

Unauthorised removal of required covers, improper use, incorrect installation or operation causes a risk of serious personal injury or material damage.

During operation, depending on their protection class, devices may have live bare components as well as hot surfaces.

The device is operated with hazardous voltage. Dangerous voltage may be present at the supply lines, contact strips and PCBs of all connecting terminals (e.g. mains input, motor connection), even if the device is not working or the motor is not rotating (e.g. caused by electronic disabling, jamming of the drive or a short circuit at the output terminals).

The device is not equipped with a master mains switch and is thus always live when connected to mains voltage. Voltages may therefore also be present at a connected motor at standstill.

A connected motor may also rotate if the drive is disconnected from the mains and possibly generate hazardous voltage.

If persons come into contact with such dangerous voltage, there is a risk of an electric shock, which can lead to serious or fatal injuries.

The fact that the status LED or other indicators are not illuminated does not indicate that the device has been disconnected from the mains and is without voltage.

The heat sink and all other metal components may heat up to temperatures above 70 °C.

Touching these parts can result in local burns to the body parts concerned (cooling times and clearance from neighbouring components must be complied with).

All work on the device, e.g. transportation, installation, commissioning and maintenance work, must be carried out by qualified personnel (observe IEC 364 or CENELEC HD 384 or DIN VDE 0100 and IEC 664 or DIN VDE 0110 and national accident prevention regulations). In particular, the general and regional installation and safety regulations for work on high voltage systems (e.g. VDE) must be complied with, as must the regulations concerning correct use of tools and the use of personal protection equipment.

During any work on the device, ensure that no foreign bodies, loose parts, moisture or dust enter or remain in the device (risk of short circuit, fire and corrosion).

Under certain setting conditions, the device or the motor connected to it may start up automatically when the mains are switched on. A machine drive by it (press / chain hoist / roller / fan etc.) may then initiate unexpected movement. This may cause various injuries, including to third parties.

Before switching on the mains, secure the danger area by warning and removing all persons from the danger area!

Further information can be found in this documentation.

Triggering of a circuit breaker

If the device is secured by a circuit breaker and if this was triggered, this may indicate that a residual current was interrupted. A component (e.g. device, cable or plug connector) in this circuit may have caused an overload (e.g. short circuit or earth fault).

A direct reset of the circuit breaker may lead to the circuit breaker not being triggered afterwards although the fault cause is still present. As a result, any current flowing into the fault location may cause overheating and ignite the surrounding material.

After each triggering of a circuit breaker, all live components within this circuit must thus be visually checked for defects and flashover tracks. Also check the connections at the device’s connection terminals.

In case of no faults found or after the replacement of the defect components, switch on the power supply by resetting the circuit breaker. Carefully observe the components keeping a safe physical distance. As soon as you observe a malfunction (e.g. smoke, heat or unusual odours), the occurrence of a new fault or if the status LED on the device does not light up, switch off the circuit breaker immediately and disconnect the defect component from the mains. Replace the defect component.

2. Qualified specialist personnel

Within the meaning of this basic safety information, qualified specialist personnel are persons who are familiar with the installation, assembly, commissioning and operation of the product and who have the qualifications appropriate to their work.

In addition, the device and the accessories associated with it must only be installed and commissioned by a qualified electrician. A qualified electrician is a person who, because of his/her technical training and experience, has sufficient knowledge with regard to

- switching on, switching off, disconnection, earthing and labelling of electric circuits and devices,
- correct maintenance and use of protective devices according to specified safety standards.

3. Intended use – general

Frequency inverters are devices for industrial and commercial systems that are used to operate three-phase asynchronous motors with squirrel-cage rotors and Permanent Magnet Synchronous Motors –

PMSM. These motors must be suitable for operation with frequency inverters, other loads must not be connected to the devices.

The devices are components intended for installation in electrical systems or machines. They must only be operated inside an enclosed control cabinet.

Technical data and information for connection conditions can be found on the rating plate and in the documentation, and must be complied with.

The devices may only be used for safety functions which are described and explicitly approved.

CE-labelled devices fulfil the requirements of the Low Voltage Directive 2014/35/EU. The stated harmonized standards for the devices are used in the declaration of conformity.

a. **Supplement: Intended use within the European Union**

   When installed in machines, commissioning of the devices (i.e. commencement of proper use) is prohibited until it has been ensured that the machine fulfils the provisions of EC Directive 2006/42/EC (Machinery Directive); EN 60204-1 must also be complied with.
   Commissioning (i.e. start-up of proper use) is only permitted if the EMC directive (2014/30/EU) has been complied with.

b. **Supplement: Intended use outside the European Union**

   The local conditions of the operator for the installation and commissioning of the device must be complied with at the usage location (see also “a. Supplement: Intended use within the European Union”).

4. Do not make any modifications.

Unauthorised changes and the use of spare parts and additional equipment tnot purchased from or recommended by NORD may cause fire, electric shock and injury.

Do not change the original coating / paint or apply additional coatings / paints.

Do not make any structural modifications to the product.

5. Phases of life

Transport, storage

The information in the manual regarding transport, storage and correct handling must be complied with.

The permissible mechanical and climatic ambient conditions (see technical data in the manual for the device) must be complied with.

If necessary, suitable, adequately dimensioned means of transport (e.g. lifting gear, rope guides) must be used.

Installation and assembly

The installation and cooling of the device must be implemented according to the regulations in the corresponding documentation. The permissible mechanical and climatic ambient conditions (see technical data in the manual for the device) must be complied with.

The device must be protected against impermissible loads. In particular, components must not be deformed and/or insulation distances must not be changed. Touching of electronic components and contacts must be avoided.

The device and its optional modules contain electrostatically sensitive components, which can be easily damaged by incorrect handling. Electrical components must not be mechanically damaged or destroyed.

Electrical connection

Ensure that the device and the motor are specified for the correct supply voltage.

Installation, maintenance and repair work must not be carried out unless the device has been disconnected from the voltage and at least 5 minutes have elapsed since the mains was switched off!

(Due to charged capacitors, hazardous voltages may be present on the device for up to 5 minutes after being switched off from the mains). Before starting work it is essential to check by measurement that for all connection terminal contacts the connections are voltage-free.

The electrical installation must be implemented according to the applicable regulations (e.g. cable cross-section, fuses, earth lead connections). Further instructions can be found in the documentation or manual for the device.

Information regarding EMC-compliant installation such as shielding, earthing, location of filters and routing of cables can be found in the documentation for the device and in the technical information manual TI 80-0011. This information must always be observed even for devices with a CE label. Compliance with the limit values specified in the EMC regulations is the responsibility of the manufacturer of the system or machine.

In case of a fault, inadequate earthing may result in electric shock, possibly with fatal consequences.

The device may only be operated with effective earth connections which comply with local regulations for large leakage currents (> 3.5 mA). Detailed information regarding connections and operating conditions can be obtained from the technical Information manual TI 80-0019.

Connection of the supply voltage may directly or indirectly set the device into operation. Contact with electrically live components may result in electric shock, possibly with fatal consequences.

All poles of cable connections (e.g. power supply) must always be disconnected.

Setup, troubleshooting and commissioning

When working on live devices, the applicable national accident prevention regulations must be complied with.

Connection of the supply voltage may directly or indirectly set the device into operation. Contact with electrically live components may result in electric shock, possibly with fatal consequences.

The parametrisation and configuration of the devices must be selected so that no hazards can occur.

Operation

Where necessary, systems in which the devices are installed must be equipped with additional monitoring and protective equipment according to the applicable safety requirements (e.g. legislation concerning technical equipment, accident prevention regulations, etc.).

All covers must be kept closed during operation.

Due to its operation, the device produces noises within the audible frequency range. These noises may cause long-term stress, discomfort and fatigue, with negative effects on concentration. The frequency range or the noise can be shifted to a less disturbing or almost inaudible range by adjustment of the pulse frequency. However, this may possibly result in derating (lower power) of the device.

Maintenance, repair and decommissioning

Installation, maintenance and repair work must not be carried out unless the device has been disconnected from the voltage and at least 5 minutes have elapsed since the mains was switched off! (Due to charged capacitors, hazardous voltages may be present on the device for up to 5 minutes after being switched off from the mains). Before starting the work, it is essential to check by measurement that all contacts of the power plug connectors or the connection terminals are voltage-free.

Disposal

The product and its parts and accessories must not be disposed of as domestic waste. At the end of its life, the product must be properly disposed of according to the local regulations for industrial waste. In particular, this product contains integrated semiconductor circuits (PCBs and various electronic components, including high power electrolytic capacitors). In case of incorrect disposal there is a risk of formation of toxic gases, which may cause contamination of the environment and direct or indirect injuries (e.g. chemical burns). In the case of high power electrolytic capacitors, there is also a risk of explosion, with the associated risk of injury.

6. Potentially explosive environment (ATEX)

The device is not approved for operation or maintenance work in potentially explosive environments (ATEX).

1.6 Explanation of markings

DANGER

Indicates an immediate danger, which may result in death or very serious injury if it is not avoided.

WARNING

Indicates a dangerous situation, which may result in death or serious injury if it is not avoided.

CAUTION

Indicates a dangerous situation, which may result in minor injuries if it is not avoided.

NOTICE

Indicates a situation, which may result in damage to the product or its environment if it is not avoided.

Information

Indicates hints for use and especially important information to ensure reliability of operation.

1.7 Standards and approvals

All devices across the entire series comply with the standards and directives listed below.

Approval	Directive		Applied standards	Certificates	Label
CE *(European Union)*	Low Voltage	2014/35/EU	EN 61800-5-1 EN 60529 EN 61800-3 EN 63000 EN 61800-9-1 EN 61800-9-2	C310600	CE
	EMC	2014/30/EU			
	RoHS	2011/65/EU			
	Delegated Directive (EU)	2015/863			
	Ecodesign	2009/125/EC			
	EU Ecodesign Directive	2019/1781			
UL *(USA)*			UL 508C	E171342	c UL us LISTED IND.CONT.EQ. E171342
CSA *(Canada)*			C22.2 No.274-13	E171342	
RCM *(Australia)*	F2018L00028		EN 61800-3	133520966	
EAC *(Eurasia)*	TR CU 004/2011, TR CU 020/2011		IEC 61800-5-1 IEC 61800-3	ЕАЭС N RU Д-DE.HB27.B.0272 1/20	EAC
UkrSEPRO *(Ukraine)*			EN 61800-5-1 EN 60529 EN 61800-3 EN 63000 EN 60947-1 EN 60947-4 EN 61558-1 EN 50581	C311900	
UKCA *(United Kingdom)*			EN 61800-5-1 EN 60529 EN 61800-3 EN 63000 EN 61800-9-1 EN 61800-9-2	C350600	UK CA

Table 4: Standards and approvals

1.7.1 UL and CSA approval

File No. E171342

The categorisation of protective equipment approved by the UL according to United States standards for the devices described in this manual is listed below, basically with the original wording. The categorisation of the individually relevant fuses or circuit breakers can be found in the “Electrical Data” section of this manual.

All devices include motor protection.

UL/CSA for devices with a nominal power of 110 kW and higher:

Devices with a nominal power of 110 kW/150 hp, 132 kW/180 hp or 163 kW/220 hp and with hardware status “ABA” (see Chapter 1.8.1 "Name plate") are **not** certified according to UL/CSA.

Conditions UL/CSA according to report

Information

"Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with manufacturer instructions, the National Electric Code and any additional local codes."

“Use 75°C Copper Conductors Only"

„These products are intended for use in a pollution degree 2 environment“

"Maximum Surrounding Air Temperature 40°C"

"Intended to be connected in the field only to an isolated secondary sources rated 24Vdc. Fuse in accordance with UL 248 rated max. 4 A must be provided externally between the isolated source and this device input".

Size	valid	description
1 - 4	For 120 V, 240 V, 400 V, 500 V models only:	"Suitable For Use On A Circuit Capable Of Delivering Not More Than 5000 rms Symmetrical Amperes, 480 Volts Maximum" and minimum one of the two following alternatives. "When Protected by Fuses manufactured by Bussmann, type _____", as listed in [1]. "When Protected by class J Fuses, rated _____ Amperes, and 600 Volts", as listed in [1].
	For 120 V models only:	"Suitable For Use On A Circuit Capable Of Delivering Not More Than 100 000 rms Symmetrical Amperes, 120 Volts Maximum, When Protected by High-Interrupting Capacity, Current Limiting Class CC, G, J, L, R, T, etc. Fuses”. The specific fuse ratings are shown in [1]. "Suitable For Use On A Circuit Capable Of Delivering Not More Than 10 000 rms Symmetrical Amperes, 120 Volts Maximum, When Protected by A Circuit Breaker Having An Interrupting Rating Not Less Than 10 000 rms Symmetrical Amperes, 480 Volts Maximum”. The specific Circuit Breaker ratings are shown in [1].
	For 240 V models only:	For 240V models only: "Suitable For Use On A Circuit Capable Of Delivering Not More Than 100 000 rms Symmetrical Amperes, 240 Volts Maximum, When Protected by High-Interrupting Capacity, Current Limiting Class CC, G, J, L, R, T, etc. Fuses”. The specific fuse ratings are shown in [1]. "Suitable For Use On A Circuit Capable Of Delivering Not More Than 10 000 rms Symmetrical Amperes, 240 Volts Maximum, When Protected by A Circuit Breaker Having An Interrupting Rating Not Less Than 10 000 rms Symmetrical Amperes, 480 Volts Maximum”. The specific Circuit Breaker ratings are shown in [1].
	For 480 V models only:	"Suitable For Use On A Circuit Capable Of Delivering Not More Than 100 000 rms Symmetrical Amperes, 480 Volts Maximum, When Protected by High-Interrupting Capacity, Current Limiting Class CC, G, J, L, R, T, etc. Fuses”. The specific fuse ratings are shown in [1]. "Suitable For Use On A Circuit Capable Of Delivering Not More Than 10 000 rms Symmetrical Amperes, 480 Volts Maximum, When Protected by A Circuit Breaker Having An Interrupting Rating Not Less Than 10 000 rms Symmetrical Amperes, 480 Volts Maximum”. The specific Circuit Breaker ratings are shown in [1].
	For 500 V models only:	"Suitable For Use On A Circuit Capable Of Delivering Not More Than 100 000 rms Symmetrical Amperes, 500 Volts Maximum, When Protected by High-Interrupting Capacity, Current Limiting Class CC, G, J, L, R, T, etc. Fuses”. The specific fuse ratings are shown in [1].

Size	valid	description
5 - 6	For 240 V models only:	"Suitable For Use On A Circuit Capable Of Delivering Not More Than 5000 rms Symmetrical Amperes, 240 Volts Maximum." "Suitable For Use On A Circuit Capable Of Delivering Not More Than 65000 rms Symmetrical Amperes, 240 V Maximum When Protected By CC, J, T or R Class Fuses or When Protected By A Circuit Breaker Having An Interrupting Rating Not Less Than 65000 rms Symmetrical Amperes, 240 Volts Maximum." "The specific fuse/circuit breaker sizes for each models are shown in [1]. Voltage rating of the fuses and circuit breakers must at least be suitable for the input voltage."
	For 480 V models only:	"Suitable For Use On A Circuit Capable Of Delivering Not More Than 5000 rms Symmetrical Amperes, 480 Volts Maximum." "Suitable For Use On A Circuit Capable Of Delivering Not More Than 65000 rms Symmetrical Amperes, 480 V Maximum When Protected By CC, J, T or R Class Fuses or When Protected By A Circuit Breaker Having An Interrupting Rating Not Less Than 65000 rms Symmetrical Amperes, 480/277 Volts Y Maximum." "The specific fuse/circuit breaker sizes for each models are shown in [1]. Voltage rating of the fuses and circuit breakers must at least be suitable for the input voltage." "480V models only for use in WYE 480/277V source, when protected by Circuit Breakers."
	For 500 V models only:	"Suitable For Use On A Circuit Capable Of Delivering Not More Than 5000 rms Symmetrical Amperes, 500 Volts Maximum." "Suitable For Use On A Circuit Capable Of Delivering Not More Than 65000 rms Symmetrical Amperes, 500 V Maximum When Protected By CC, J, T or R Class Fuses or When Protected By A Circuit Breaker Having An Interrupting Rating Not Less Than 65000 rms Symmetrical Amperes, 480/277 Volts Y Maximum." "The specific fuse/circuit breaker sizes for each models are shown in [1]. Voltage rating of the fuses and circuit breakers must at least be suitable for the input voltage." "480V models only for use in WYE 480/277V source, when protected by Circuit Breakers."
7	For 240 V models only:	"Suitable For Use On A Circuit Capable Of Delivering Not More Than 100 000 rms Symmetrical Amperes, 240 Volts Maximum, When Protected by High-Interrupting Capacity, Current Limiting Class CC, G, J, L, R, T, etc. Fuses". The specific fuse ratings are shown in [1]. "Suitable For Use On A Circuit Capable Of Delivering Not More Than 65 000 rms Symmetrical Amperes, 240 Volts Maximum, When Protected by A Circuit Breaker Having An Interrupting Rating Not Less Than 65 000 rms Symmetrical Amperes, 480 Volts Maximum". The specific Circuit Breaker ratings are shown in [1].
	For 480 V models only:	"Suitable For Use On A Circuit Capable Of Delivering Not More Than 100 000 rms Symmetrical Amperes, 480 Volts Maximum, When Protected by High-Interrupting Capacity, Current Limiting Class CC, G, J, L, R, T, etc. Fuses". The specific fuse ratings are shown in [1]. "Suitable For Use On A Circuit Capable Of Delivering Not More Than 65 000 rms Symmetrical Amperes, 480 Volts Maximum, When Protected by A Circuit Breaker Having An Interrupting Rating Not Less Than 65 000 rms Symmetrical Amperes, 480 Volts Maximum". The specific Circuit Breaker ratings are shown in [1].

Size	valid	description
8 – 9	For 480 V models only:	“Suitable For Use On A Circuit Capable Of Delivering Not More Than 10 000 (18 000 for cat. No. …-163-340) rms Symmetrical Amperes, 480 Volts Maximum” and minimum one of the two following alternatives. “When Protected by class RK5 Fuses or faster, rated _____ Amperes, and 480 Volts”, as listed in [1]. “When Protected by class J Fuses or faster, rated _____ Amperes, and 480 Volts”, as listed in [1]. “When Protected by Circuit Breaker (inverse time trip type) in accordance with UL 489, rated _____ Amperes, and 480 Volts”, as listed in [1]. “Suitable For Use On A Circuit Capable Of Delivering Not More Than 10 000 (18 000 for cat. No. …-163-340) rms Symmetrical Amperes, 480 Volts Maximum” “When Protected by Circuit Breaker (inverse time trip type) in accordance with UL 489, rated _____ Amperes, and 480 Volts”, as listed in [1].
		"Suitable For Use On A Circuit Capable Of Delivering Not More Than 100 000 rms Symmetrical Amperes, 480 Volts Maximum, When Protected by High-Interrupting Capacity, Current Limiting Class CC, G, J, L, R, T, etc. Fuses”. The specific fuse ratings are shown in [1].
		"Suitable For Use On A Circuit Capable Of Delivering Not More Than 65 000 rms Symmetrical Amperes, 480 Volts Maximum, When Protected by A Circuit Breaker Having An Interrupting Rating Not Less Than 65 000 rms Symmetrical Amperes, 480 Volts Maximum”. The specific Circuit Breaker ratings are shown in [1].

1) 📖 7.3

1.8 Type code / nomenclature

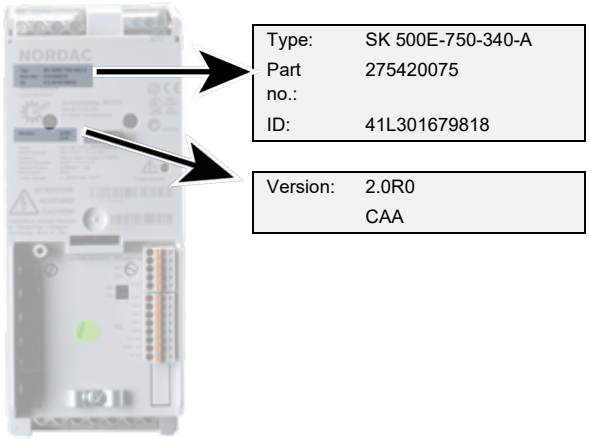
Unique type codes have been defined for the individual modules and devices. These provide individual details of the device type and its electrical data, protection class, fixing version and special versions. A differentiation is made according to the following groups:

	Frequency inverter

	Option module

1.8.1 Name plate

All relevant information for the device, including information for the identification of the device, can be obtained from the name plate.



Typ:	Type/designation
Part-No:	Part number
ID:	Identification number
Version:	Software/hardware version
Input	Mains voltage
Input Current	Input current
Output	Output voltage
Output Current	Output current
Output Power	Output power
Protection	Protection class
Temp. Range	Temperature range
Dissipation	Energy efficiency

Frequency inverter type code

SK 530E-370-323-A(-CP)

CP = cold plate or “external heat sink” version variants

Radio interference suppression filter: O = without, **A** = Class **A1(C2)** or B (C1)

Mains voltage: x12 = 115 V, x**23** = **230** V, x40 = 400 V, x50 = 500 V

Number of mains phases: 1xx = single-phase, **3**xx = **3**-phase*

Pre-decimal positions of power: **0** = **0**.xx, 1 = 0x.x0, 2 = 0xx.0

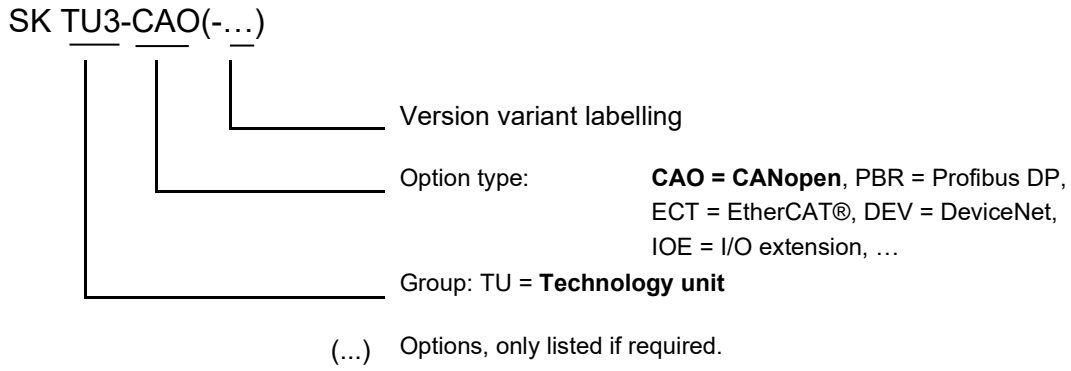
Nominal device power: 250 = 0.25 kW, **37**0 = 0.**37 kW**, ... 163 = 160.0 kW

Device series: SK 500E, SK 505E, SK 510E, SK 511E, SK 515E
SK 520E, **SK 530E**, SK 535E, SK 540E, SK 545E

(…) Options, only listed if required.

*) Designation “3” also includes combined devices which are intended for single-phase and three-phase operation (see also technical data)

Technology unit (optional module) type code



2 Assembly and installation

SK 500E frequency inverters are available in various sizes depending on the output. Attention must be paid to a suitable position when installing.

The equipment requires sufficient ventilation to protect against overheating. For this the minimum guideline distances from adjacent components above and below the frequency inverter, which could obstruct the air flow apply. (above > 100 mm, below > 100 mm)

Distance from device: Mounting can be immediately next to each other. However, for the use of brake resistances mounted below the frequency inverter (not possible with …-CP devices), the greater width must be taken into consideration, particularly in combination with temperature switches on the brake resistor!

Installation position: The installation position is normally vertical. It must be ensured that the cooling ribs on the rear of the frequency inverter are covered with a flat surface to provide good convection.

Warm air must be vented above the device!

Fig. 1 Mounting distances for SK 5xxE

If several inverters are arranged above each other, it must be ensured that the upper air entry temperature limit is not exceeded (chapter 7). If this is the case, it is recommended that an "obstacle" (e.g. a cable duct) is mounted between the inverters so that the direct air flow (rising warm air) is impeded.

Heat dissipation: If the frequency inverter is installed in a control cabinet, adequate ventilation must be ensured. The heat dissipation in operation is approx. 5 % (according to the size and equipment of the device) of the rated power of the frequency inverter.

2.1 SK 5xxE in standard version

Install the frequency inverter directly on the rear wall of a control cabinet. Two wall-mounting brackets (for sizes 5–7: four wall-mounting brackets) are enclosed, which must be inserted into the heat sink on the rear of the device. For size 8 and higher, the mounting device is already integrated.

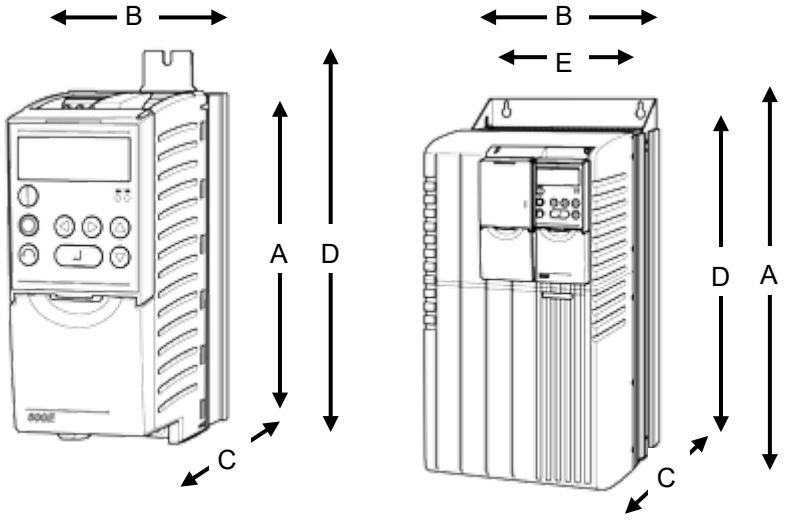
To reduce the control cabinet depth, for sizes 1 ...4, the wall-mounting brackets can be inserted on the side of the heat sink.

Make sure that the rear of the heat sink is covered with a flat surface and that the device is mounted vertically. This enables optimum convection and ensures correct operation.

Device type	Size	Housing dimensions			Wall mounting			Weight
		A	B	C	D	E[1)]	∅	
SK 5xxE-250-112… to SK 5xxE-750-112…	Size 1	186	74 [2)]	153	220	/	5.5	1.4
SK 5xxE-250-323… to SK 5xxE-750-323…	Size 1	186	74 [2)]	153	220	/	5.5	1.6
SK 5xxE-550-340… to SK 5xxE-750-340…	Size 1	186	74 [2)]	153	220	/	5.5	1.6
SK 5xxE-111-112…	Size 1	186	74 [2)]	153	220	/	5.5	1.8
SK 5xxE-111-340… to SK 5xxE-221-340…	Size 2	226	74 [2)]	153	260	/	5.5	1.8
SK 5xxE-111-323… to SK 5xxE-221-323…	Size 2	226	74 [2)]	153	260	/	5.5	2.0
SK 5xxE-301-… to SK 5xxE-401- …	Size 3	241	98	181	275	/	5.5	2.7
SK 5xxE-551-340… to SK 5xxE-751-340…	Size 4	286	98	181	320	/	5.5	3.1
SK 5xxE-551-323… to SK 5xxE-751-323…	Size 5	327	162	224	357	93	5.5	8.0
SK 5xxE-112-340… to SK 5xxE-152-340…	Size 5	327	162	224	357	93	5.5	8.0
SK 5xxE-112-323…	Size 6	367	180	234	397	110	5.5	10.3
SK 5xxE-182-340… to SK 5xxE-222-340…	Size 6	367	180	234	397	110	5.5	10.3
SK 5xxE-152-323… to SK 5xxE-182-323…	Size 7	456	210	236	485	130	5.5	15.0
SK 5xxE-302-340… to SK 5xxE-372-340…	Size 7	456	210	236	485	130	5.5	16.0
SK 5xxE-452-340… to SK 5xxE-552-340…	Size 8	598	265	286	582	210	8.0	20.0
SK 5xxE-752-340…	Size 9	636	265	286	620	210	8.0	25.0
SK 5xxE-902-340…	Size 9	636	265	286	620	210	8.0	30.0
SK 5xxE-113-340…	Size 10	720	395	292	704	360	8.0	46.0
SK 5xxE-133-340…	Size 10	720	395	292	704	360	8.0	49.0
SK 5xxE-163-340…	Size 11	799	395	292	783	360	8.0	52.0
400 V (…-340…) and 500 V (…-350…) – FI: Identical dimensions and weights		All dimensions in [mm]						In [kg]

1) Sizes 10 and 11: The specified value corresponds to the distance between the external fastenings. A third mounting hole is located in the centre.

2) When using footprint braking resistors: 88 mm



A =	Total length [1]
B =	Total width [1]
C =	Total height [1]
D =	Longitudinal hole spacing [2]
E =	Lateral hole spacing [2]

1) Delivery state

2) Fixing dimensions

2.2 SK 5xxE…-CP in ColdPlate version

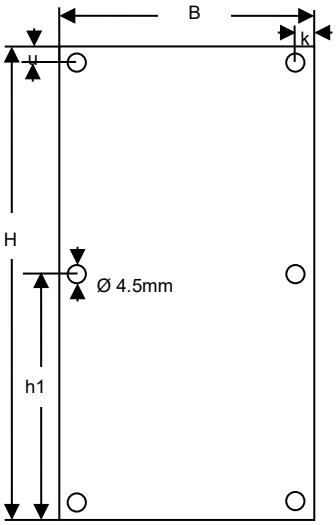
Instead of a cooling element/fan, ColdPlate versions of the frequency inverter have a flat metal plate on the rear side which is mounted on an existing mounting plate (e.g. the rear wall of the control cabinet) so as to provide thermal conduction. A liquid cooling medium (water, oil) may also be passed through the mounting surface. In this way, not only is the waste heat from the frequency inverter dissipated more effectively, but also the waste heat from the inverter is prevented from remaining inside the control cabinet. In addition to the optimisation of the power reserved and the service life of the inverter, this also causes less thermal load on the inside of the control cabinet.

A further advantage of the ColdPlate version is the reduced installation depth of the device and the fact that in general, there is no need for a fan on the frequency inverter.

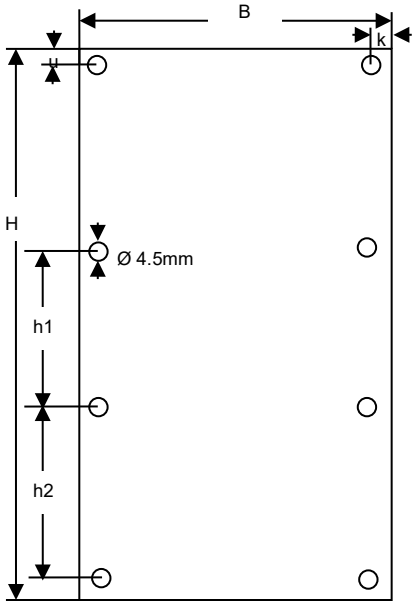
Bottom-mounted brake resistors (SK BR4-…) cannot be mounted directly.

Frequency inverter type	Size	Envelope dimensions [mm]			ColdPlate dimensions [mm]				Weight Approx. [kg]
		A / H	**B**	**C**	**h1**	**h2**	**u / k**	**Thickness**	
SK 5xxE-250- …-CP SK 5xxE-750- …-CP	1	182	95	119	91	-	5.5	10	1.3
SK 5xxE-111- …-CP SK 5xxE-221- …-CP	2	222	95	119	111	-	5.5	10	1.6
SK 5xxE-301- …-CP SK 5xxE-401- …-CP	3	237	120	119	75.33	75.33	5.5	10	1.9
SK 5xxE-551- 340…-CP SK 5xxE-751- 340…-CP	4	282	120	119	90.33	90.33	5.5	10	2.3

SK 5xxE-…CP



ColdPlate size 1 and size 2



ColdPlate size 3 and size4

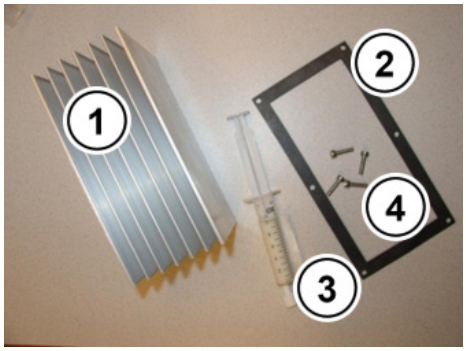
(Please see also chapter 🕮 7.4 "General conditions for ColdPlate technology".)

2.3 External heat sink kit

External heat sink technology is an optional supplementation to the cold plate device. It is used when external cooling is required but no liquid-cooled mounting plate is available. A heat sink is mounted on the cold plate devices, which reaches the external, air-cooled environment through a recess in the rear wall of the control cabinet. The convection takes place outside the control cabinet. This provides the same advantages as the cold plate technology.

Device type	Size	Type of external heat sink kit	Part no.
SK 5xxE-250- …-CP SK 5xxE-750- …-CP	1	SK TH1-1	275999050
SK 5xxE-111- …-CP SK 5xxE-221- …-CP	2	SK TH1-2	275999060

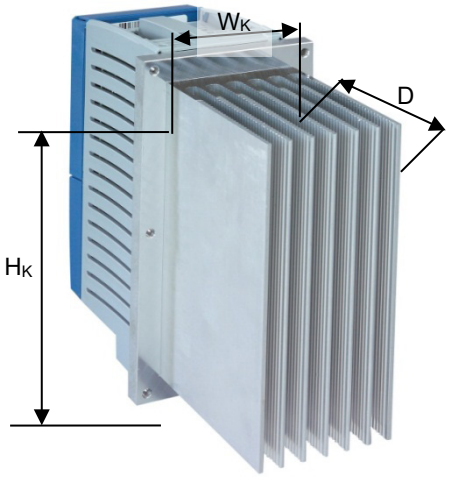
Scope of delivery



1 = Heat sink
2 = Seal
3 = Heat conducting paste
4 = M4x16 cap screws with hexagon socket (4 pieces)

Dimensions

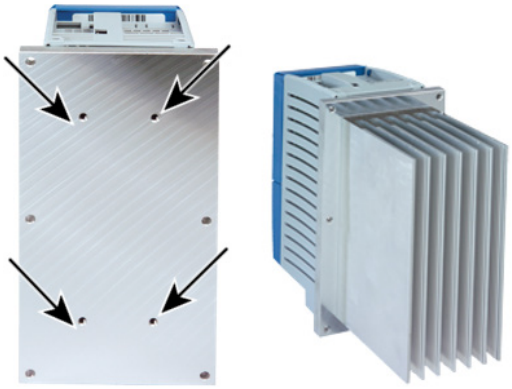
Type of external heat sink kit	Heat sink dimensions [mm]			Approx. heat sink weight [kg]
	HK	WK	DK	
SK TH1-1	157	70	100	1.5
SK TH1-2	200	70	110	1.7



Installation

For installation, a recess the size of the heat sink must be prepared in the control cabinet wall (observe the bearing capacity).

1. Apply heat conducting paste to the cold plate of the SK 5xxE.
2. Mount the heat sink securely to the cold plate using the four enclosed screws.
3. Remove the heat conducting paste that has escaped.
4. Place a seal between the frequency inverter and control cabinet wall (control cabinet interior).
5. Insert the device by leading the external heat sink out of the control cabinet through the recess in the control cabinet wall.
6. Fasten the frequency inverter to the control cabinet wall using all six or eight existing holes of the cold plate.



Information

Protection class IP54

If mounted correctly, the control cabinet achieves IP54 from the outside at the installation point.

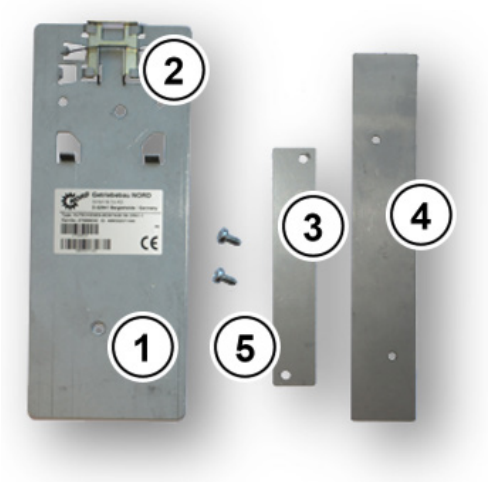
2.4 Snap-on mounting rail kit SK DRK1-…

The snap-on mounting rail set SK DRK1-1 enables size 1 or 2 frequency inverters to be mounted on a standard TS35 (EN 50022) mounting rail.

Frequency inverter type	Size	Type Snap-on rail mounting kit	Part. No.
SK 5xxE-250- … SK 5xxE-750- …	1	**SK DRK1-1**	275999030
SK 5xxE-111- … SK 5xxE-221- …	2	**SK DRK1-2**	275999040

Scope of delivery

1= Adapter for snap-on rail mounting
2= Clamp
3= Spacer
4= Fastening plate
5= Screws(2x)

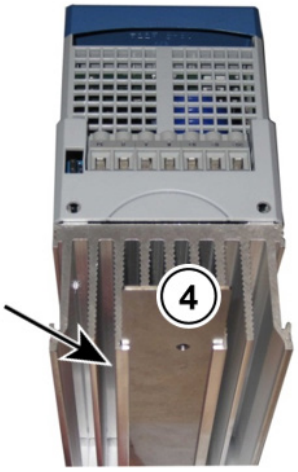


Assembly

1. Push the fastening plate (4) into the guide on the heat sink (arrow);
2. place the spacer plate (3) on the fastening plate (4);
3. connect the snap-on rail mounting adapter (1) and the components (3) + (4) with screws (5).

During assembly, take care that the stirrup (2) points upwards (mains connection side of the inverter).

Then the inverter can be clipped directly onto the snap-on rail. To release the frequency inverter, the stirrup (2) must be pulled a few millimetres out of the snap-on rail.



2.5 EMC Kit

For optimum EMC-compliant wiring, the optional EMC Kit must be used.

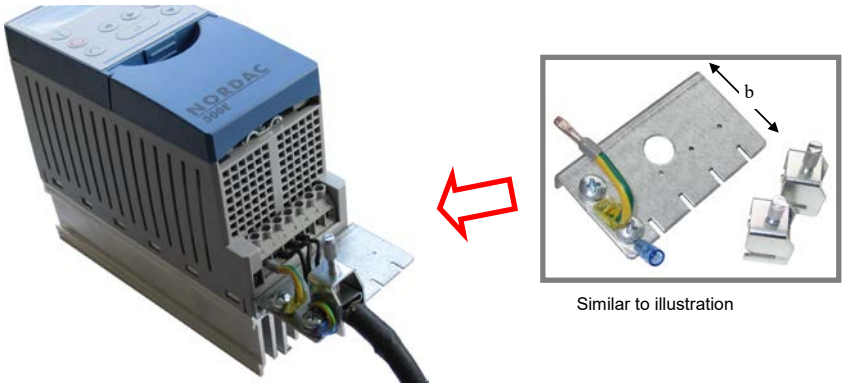


Fig. 2: EMC Kit SK EMC2-x

Frequency inverter type	Size	EMC Kit	Document	Dimension "b"
SK 5xxE-250- … SK 5xxE-750-	Size 1	SK EMC 2-1 **Part No. 275999011**	TI 275999011	42 mm
SK 5xxE-111- … SK 5xxE-221-	Size 2			
SK 5xxE-301- … SK 5xxE-401-	Size 3	SK EMC 2-2 **Part No. 275999021**	TI 275999021	42 mm
SK 5xxE-551-340- … SK 5xxE-751- 340-	Size 4			
SK 5xxE-551-323- … SK 5xxE-751- 323- SK 5xxE-112-340- … SK 5xxE-152- 340-	Size 5	SK EMC 2-3 **Part No. 275999031**	TI 275999031	52 mm
SK 5xxE-112-323- SK 5xxE-182-340- … SK 5xxE-222- 340-	Size 6	SK EMC 2-4 **Part No. 275999041**	TI 275999041	57 mm
SK 5xxE-152-323- … SK 5xxE-182- 323- SK 5xxE-302-340- … SK 5xxE-372- 340-	Size 7	SK EMC 2-5 **Part No. 275999051**	TI 275999051	57 mm
SK 5xxE-452-340- … SK 5xxE-902- 340-	Size 8/9	SK EMC 2-6 **Part No. 275999061**	TI 275999061	100 mm
SK 5xxE-113-340- … SK 5xxE-163- 340-	Size 10/11	SK EMC 2-7 **Part No. 275999071**	TI 275999071	82 mm

Table 5: EMC Kit SK EMC2-x

Information

The EMC Kit cannot be combined with ...-CP (ColdPlate) devices. Any cable shielding must be earthed to a large area of the mounting surface.

Alternatively, the EMC kit can also be used purely as a strain relief (e.g. for the connection cables of a bus system) (observe the bending radii).

2.6 Braking resistor (BR)

⚠ CAUTION

Danger of burns

The module and all other metal components can heat up to temperatures above 70 °C.

- Prior to carrying out work on the components, sufficient cooling time must be ensured to prevent injuries (local burns) on body parts that come into contact with the components.
- Sufficient distance must be kept during assembly to prevent damage to adjacent objects.

During dynamic braking (frequency reduction) of a three-phase motor, electrical energy is fed back to the frequency inverter. An external braking resistor can be used to prevent the frequency inverter from being shut down due to overvoltage. The integrated brake chopper (electronic switch) pulses the DC link voltage into the braking resistor. The excess energy is converted into heat.

For inverter powers **up to 7.5 kW** (230 V: up to 4.0 kW) a standard footprint resistor **(SK BR4-..., IP40)** can be used. Approval: UL, cUL

Note: Footprint braking resistors cannot be mounted directly on …-CP (cold plate) devices.

SK BR4-... Size 1 SK BR4-... Size 2

Figure 3: SK BR4-... footprint braking resistor

For frequency inverters of **3 kW and higher**, chassis braking resistors **(SK BR2-..., IP20)** are available. Mount these in the control cabinet in the vicinity of the frequency inverter. Approval: UL, cUL

SK BR2-... Size 3 SK BR2-... Size 4 and higher

Figure 4: SK BR2-... chassis braking resistor

2.6.1 Electrical data for braking resistor

Item	Type	Part no.	R [Ω]	P [W]	Short-time power* [kW]				Connecting cable / connection terminals
					1.2 s	7.2 s	30 s	72 s	
1	SK BR4-240/100	275991110	240	100	2.2	0.8	0.3	0.15	2 x 1.9 mm², AWG 14/19 L = 0.5 m
2	SK BR4-150/100	275991115	150	100	2.2	0.8	0.3	0.15	
3	SK BR4-75/200	275991120	75	200	4.4	1.6	0.6	0.3	
4	SK BR4-35/400	275991140	35	400	8.8	3.2	1.2	0.6	2 x 2.5 mm², AWG 14/19 L = 0.5 m
5	SK BR2-35/400-C	278282045	35	400	12	3.8	1.2	0.6	Terminals 2 x 10 mm²
6	SK BR2-22/600-C	278282065	22	600	18	5.7	1.9	0.9	
7	SK BR2-12/1500-C	278282015	12	1500	45	14	4.8	2.2	
8	SK BR2-9/2200-C	278282122	9	2200	66	20	7.0	3.3	
9	SK BR4-400/100	275991210	400	100	2.2	0.8	0.3	0.15	2 x 1.9 mm², AWG 14/19 L = 0.5 m
10	SK BR4-220/200	275991220	220	200	4.4	1.6	0.6	0.3	
11	SK BR4-100/400	275991240	100	400	8.8	3.2	1.2	0.6	2 x 2.5 mm², AWG 14/19 L = 0.5 m
12	SK BR4-60/600	275991260	60	600	13	4.9	1.8	0.9	
13	SK BR2-100/400-C	278282040	100	400	12	3.8	1.2	0.6	Terminals 2 x 10 mm²
14	SK BR2-60/600-C	278282060	60	600	18	5.7	1.9	0.9	
15	SK BR2-30/1500-C	278282150	30	1500	45	14	4.8	2.2	
16	SK BR2-22/2200-C	278282220	22	2200	66	20	7.0	3.3	
17	SK BR2-12/4000-C	278282400	12	4000	120	38	12	6.0	
18	SK BR2-8/6000-C	278282600	8	6000	180	57	19	9.0	
19	SK BR2-6/7500-C	278282750	6	7500	225	71	24	11	Terminals 2 x 25 mm²
20	SK BR2-3/7500-C	278282753	3	7500	225	71	24	11	
21	SK BR2-3/17000-C	278282754	3	17000	510	161	54	25	

*) Maximum duration within 120 s

Table 6: Electrical data for braking resistors SK BR2-… and SK BR4-…

The chassis braking resistors (SK BR2-…) listed above are equipped with a temperature switch at the factory. For footprint braking resistors (SK BR4-…), two different temperature switches with different triggering temperatures are optionally available.

In order to use the signal from the temperature switch, it must be connected to a free digital input of the frequency inverter and, for example, parameterised with the function “Voltage disable” or “Quick stop”.

NOTICE

Impermissible heating

If the footprint resistor is mounted below the frequency inverter, the frequency inverter may heat up impermissibly. This may result in damage to the cooling system of the device (fan).

- Use temperature switches with a nominal switch-off temperature of 100 °C (part no. 275991200) if you mount the footprint resistor below the frequency inverter.

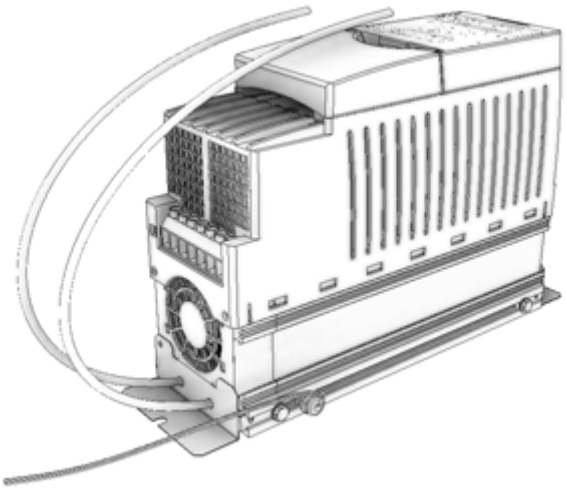
Bimetallic temperature switch							
For SK...	**Part no.**	**Protec-tion class**	**Voltage**	**Current**	**Nominal switching temperature**	**Dimensions**	**Connecting cable / connection terminals**
BR4-...	275991100	IP40	250 V AC 24 V DC	2.5 A for cosφ = 1 1.6 A for cosφ = 0.6	180 °C ± 5 K	Width +10 mm (one side)	2 x 0.8 mm², AWG 18 L = 0.5 m
BR4-...	275991200				100 °C ± 5 K		
BR2-...	Integrated	IP00	250 V AC 125 V AC 30 V DC	10 A 15 A 5 A	180 °C ± 5 K	Internal	Terminals 2 x 4 mm²

Table 7: Data of the braking resistor temperature switch

2.6.2 Dimensions of bottom-mounted BR SK BR4

Resistor type	Size	A	B	C	Fixing dimensions	
					D	Ø
SK BR4-240/100 SK BR4-150/100 SK BR4-400/100	Size 1	230	88	175	220	5.5
SK BR4- 75/200 SK BR4-220/200	Size 2	270	88	175	260	5.5
SK BR4-35/400 SK BR4-100/400	Size 3	285	98	239	275	5.5
SK BR4-60/600	Size 4	330	98	239	320	5.5
C = installation depth of the frequency inverter + bottom-mounted brake resistor						all dimensions in mm

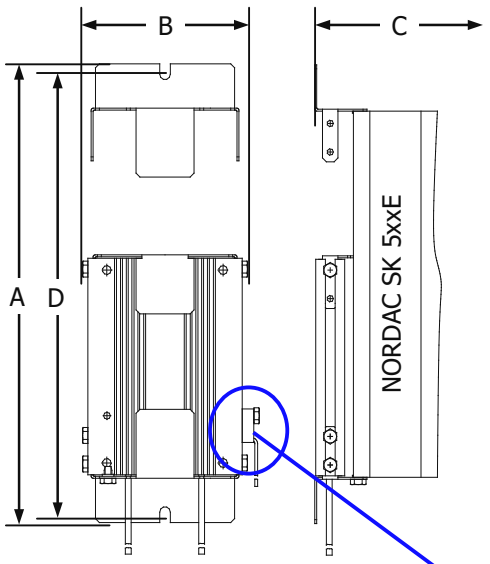
Table 8: Dimensions of bottom-mounted brake resistor SK BR4-...



Example: SK 500E, BG2 and BR4-75-… with temperature switch (Part No. 275991200)

Fig. 5: Illustration of mounting the BR4- on the frequency inverter

SK BR4-... Size 1



SK BR4-... Size 2

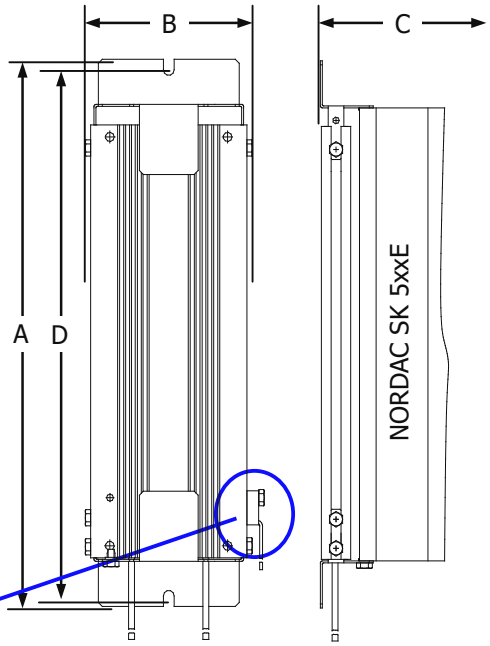
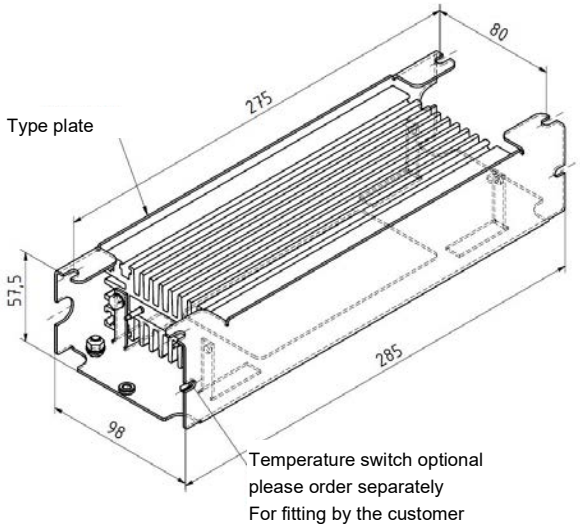
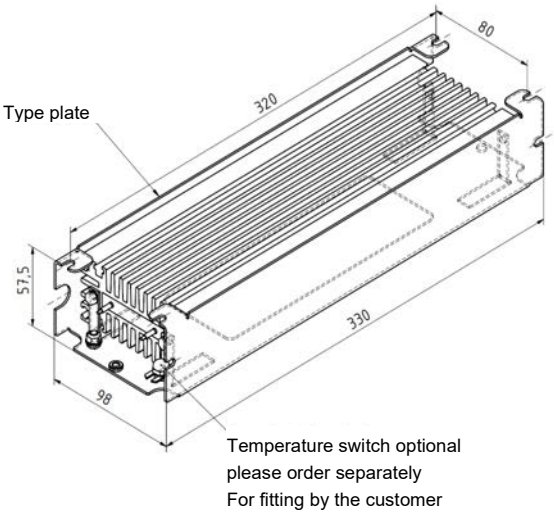


Illustration with optional temperature switch
Part No.: 275991100



SK BR4-... Size 3



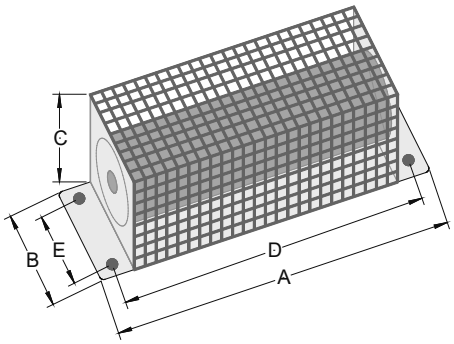
SK BR4-... Size 4

Separate data sheets are available for bottom-mounted SK BR4 brake resistors above Size 3. These can be downloaded from www.nord.com.

Inverter type	Brake resistor type	Part No.	Data sheet
SK 5xxE-301-323- … -401-323-	**SK BR4-35/400**	275991140	TI014 275991140
SK 5xxE-301-340- … -401-340-	**SK BR4-100/400**	275991240	TI014 275991240
SK 5xxE-551-340- … -751-340-	**SK BR4-60/600**	275991260	TI014 275991260

2.6.3 Dimensions of chassis BR SK BR2

Resistor type	A	B	C	Fixing dimensions			Weight
				D	E	∅	
SK BR2-100/400-C	178	100	252	150	90	4.3	1.6
SK BR2- 35/400-C							
SK BR2- 60/600-C	385	92	120	330	64	6.5	1.7
SK BR2- 22/600-C							
SK BR2- 30/1500-C	585	185	120	526	150	6.5	5.1
SK BR2- 12/1500-C							
SK BR2- 22/2200-C	485	275	120	426	240	6.5	6.4
SK BR2- 9/2200-C							
SK BR2- 12/4000-C	585	266	210	526	240	6.5	12.2
SK BR2- 8/6000-C	395	490	260	370	380	10.5	13.0
SK BR2- 6/7500-C	595	490	260	570	380	10.5	22.0
SK BR2- 3/7500-C							
SK BR2- 3/17000-C	795	490	260	770	380	10.5	33.0
All dimensions in mm							[kg]



SK BR2-... FI size 3 and above
(*Schematic diagram, model varies according to power)*

Table 9: Dimensions of chassis brake resistor SK BR2-...

2.6.4 Brake resistor assignments

The brake resistor (BW) which is directly assigned to the frequency inverter according to the following table is dimensioned for approx. 10% of the rated power of the inverter. It is therefore suitable for brief brake operation or brake operation with a flat brake ramp, in which only a low total braking energy occurs.

Frequency inverter				BW [1]
U [V]	$P_{100\%}$ [kW]	R_{min} [Ω]	SK 5xxE-	
115	0.25	240	250-112-	1 / -
	0.37	190	370-112-	1 / -
	0.55	140	550-112-	2 / -
	0.75	100	750-112-	2 / -
	1.1	75	111-112-	2 / -
230	0.25	240	250-323-	1 / -
	0.37	190	370-323-	1 / -
	0.55	140	550-323-	2 / -
	0.75	100	750-323-	2 / -
	1.1	75	111-323-	3 / -
	1.5	62	151-323-	3 / -
	2.2	46	221-323-	3 / -
	3.0	35	301-323-	4 / 5
	4.0	26	401-323-	4 / 5
	5.5	19	551-323-	6 / -
	7.5	14	751-323-	6 / -
	11.0	10	112-323-	7 / -
	15.0	7	152-323-	8 / -
	18.5	6	182-323-	8 / -

Frequency inverter				BW [1]
U [V]	$P_{100\%}$ [kW]	R_{min} [Ω]	SK 5xxE-	
400	0.55	390	550-340-	9 / -
	0.75	300	750-340-	9 / -
	1.1	220	111-340-	10 / -
	1.5	180	151-340-	10 / -
	2.2	130	221-340-	10 / -
	3.0	91	301-340-	11 / 13
	4.0	74	401-340-	11 / 13
	5.5	60	551-340-	12 / 14
	7.5	44	751-340-	12 / 14
	11.0	29	112-340-	15 / -
	15.0	23	152-340-	15 / -
	18.5	18	182-340-	16 / -
	22.0	15	222-340-	16 / -
	30.0	9	302-340-	17 / -
	37.0	9	372-340-	17 / -
	45.0	8	452-340-	18 / -
	55.0	8	552-340-	18 / -
	75.0	6	752-340-	19 / -
	90.0	6	902-340-	19 / -
	110	3.2	113-340-	19 / -
	132	3	133-340-	20 / 21
	160	2.6	163-340-	21 / 20

1) Standard brake resistor according to Table (chapter 2.6.1), "Standard type / Alternative type (if available)“

Special brake resistors must be planned if higher brake powers occur (steeper braking ramps, longer braking processes (lifting equipment). Alternatively, it may also be possible to implement the required braking power by the combination of standard brake resistors (see chapter 2.6.5 "Combination of brake resistors").

2.6.5 Combination of brake resistors

By the combination of 2 or more standard brake resistors it is possible to implement considerably higher braking powers than are possible with the directly assigned standard brake resistor.

However, the following must be noted when doing this:

- ***Series connection***

  The powers and ohmic resistances are added. If the resulting ohmic resistance is too high, the braking power (e.g. a brief higher braking pulse) may not be able to be dissipated. As a result, the frequency inverter goes into an error state (Error E 5.0).

- ***Parallel connection***

  The powers and conduction values are added, the total resistance reduces. If the resulting ohmic resistance is too low, the current to the brake chopper will be too high. As a result, the frequency inverter goes into an error state (Error E 3.1). **In addition, the inverter may also be damaged**.

With the brake resistor combinations from the standard range which are listed below, at least 80% of the braking power in comparison with the rated power of the frequency inverter can be implemented. Taking into account the efficiency of the drive unit as a whole, these combinations can be used for almost all drive applications. It must be noted that in this case, the bottom-mounted brake resistors must be mounted close to the inverter.

Above an inverter power of > 55 kW or for greater required continuous powers or brief powers, a suitable brake resistor must be planned, as the necessary parameters can no longer be achieved with a sensible combination of brake resistors from the standard range.

Frequency inverter				Braking resistors		Resulting values			
U [V]	$P_{100\%}$ [kW]	R_{min} [Ω]	SK 5xxE-	Connection [1]	Example [2]	R [Ω]	P [kW]	P_{peak} [kW] [3]	Pulse energy [kWs] [4]
115	0.25	240	250-112-	2 – 2	b	300	0.2	0.6	0.8
	0.37	190	370-112-	2 – 2 – 2	b	450	0.3	0.4	0.5
	0.55	140	550-112-	3 – 3 – 3	b	225	0.6	0.8	1.0
	0.75	100	750-112-	3 – 3 – 3	b	225	0.6	0.8	1.0
	1.1	75	111-112-	5 – 5 – 5	b	105	1.2	1.8	2.2
230	0.25	240	250-323-	2 – 2	b	300	0.2	0.6	0.8
	0.37	190	370-323-	2 – 2 – 2	b	450	0.3	0.4	0.5
	0.55	140	550-323-	3 – 3 – 3	b	225	0.6	0.8	1.0
	0.75	100	750-323-	3 – 3 – 3	b	225	0.6	0.8	1.0
	1.1	75	111-323-	5 – 5 – 5	b	105	1.2	1.8	2.2
	1.5	62	151-323-	5 – 5 – 5	b	105	1.2	1.8	2.2
	2.2	46	221-323-	6 – 6 – 6	b	66	1.8	2.9	3.5
	3.0	35	301-323-	(14 // 14) – (14 // 14)	a	60	2.4	3.2	3.8
	4.0	26	401-323-	(15 // 15) – (15 // 15)	a	30	6.0	6.4	6.0
	5.5	19	551-323-	(6 // 6) – (16 // 16)	a	22	5.6	8.8	7.5
	7.5	14	751-323-	17 – 17	b	24	8.0	8.0	7.5
	11.0	10	112-323-	18 – 18	b	16	12	12	14
	15.0	7	152-323-	19 – 19	b	12	15	16	19
	18.5	6	182-323-	20 – 20	b	6	15	32	28

Frequency inverter				Braking resistors		Resulting values			
U [V]	$P_{100\%}$ [kW]	R_{min} [Ω]	SK 5xxE-	Connection [1]	Example [2]	R [Ω]	P [kW]	P_{peak} [kW] [3]	Pulse energy [kWs] [4]
400	0.55	390	550-340-	10 – 10 – 10	b	660	0.6	0.9	1.0
	0.75	300	750-340-	10 – 10 – 10	b	660	0.6	0.9	1.0
	1.1	220	111-340-	13 – 13 – 13	b	300	1.2	2.1	2.5
	1.5	180	151-340-	13 – 13 – 13	b	300	1.2	2.1	2.5
	2.2	130	221-340-	14 – 14 – 14	b	180	1.8	3.5	3.0
	3.0	91	301-340-	14 – 14 – 14 – 14	b	240	2.4	2.6	3.2
	4.0	74	401-340-	15 – 15 – 15	b	90	4.5	7.1	6.0
	5.5	60	551-340-	15 – 15 – 15	b	90	4.5	7.1	8.5
	7.5	44	751-340-	16 – 16 – 16	b	66	6.6	9.7	9.0
	11.0	29	112-340-	17 – 17 – 17	b	36	12	17	20
	15.0	23	152-340-	17 – 17 – 17	b	36	12	17	20
	18.5	18	182-340-	18 – 18 – 18	b	24	18	26	28
	22.0	15	222-340-	18 – 18 – 18	b	24	18	26	28
	30.0	9	302-340-	20 – 20 – 20 – 20	b	12	30	53	52
	37.0	9	372-340-	20 – 20 – 20 – 20	b	12	30	53	52
	45.0	8	452-340-	20 – 21 – 21	b	9	41	71	78
	55.0	8	552-340-	21 – 21 – 21	b	9	51	71	78

1) Type of connection of standard brake resistors from Table (chapter 2.6.1),
Here: "//" = connected in parallel, "-" = connected in series

2) Connection example according to the following diagram

3) Maximum possible peak braking power with the stated resistor combination

4) Maximum possible pulse energy with 1% switch-on duration (1.2 sec once within 120 sec.) taking into account the absolute limit of the frequency inverter

Table 10: Combination of standard brake resistors

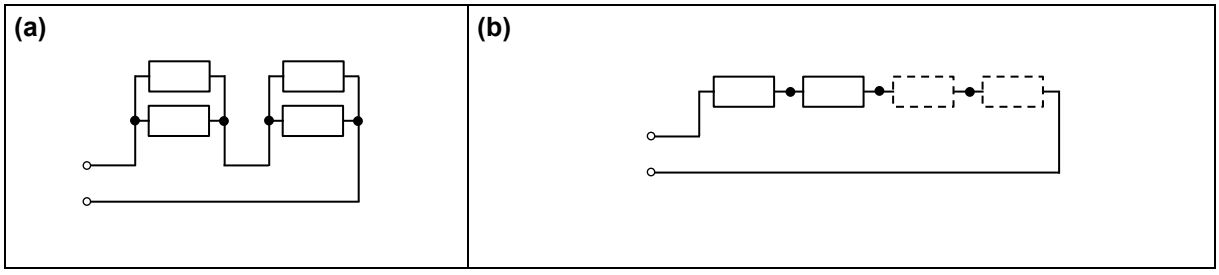


Fig. 6: Typical brake resistor connections

2.6.6 Monitoring of the braking resistor

To prevent overload of the braking resistor, it should be monitored during operation. The most reliable method is thermal monitoring with a temperature switch that is mounted directly on the braking resistor.

2.6.6.1 Monitoring with a temperature switch

As standard, SK BR2-… braking resistors are equipped with a suitable temperature switch. For SK BR4-…, suitable temperature switches are optionally available (see chapter 2.6.1 "Electrical data for braking resistor"). When mounting a footprint braking resistor below the frequency inverter **(SK BR4-…)**, it must be ensured that the temperature switch with **reduced switching threshold (100 °C)** is used.

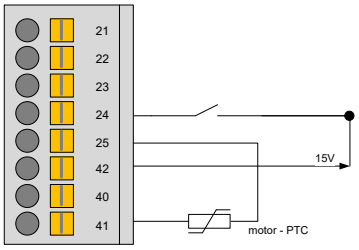
The temperature switch must be evaluated by an external control unit.

Alternatively, the temperature switch can be evaluated directly by the frequency inverter. For this purpose, it must be connected to a free digital input. This digital input must be parameterised with function {10} “Voltage disable”.

Example, SK 520E

- Connect the temperature switch to digital input 4 (terminal 42 / 24)
- Parameterise parameter**P423** to function {10} “*Voltage disable*”

The switch opens if the maximum permissible temperature of the braking resistor is reached. The output of the frequency inverter is disabled. The motor runs down to a standstill.



2.6.6.2 Monitoring with current measurement and calculation

As an alternative to direct monitoring with a temperature switch, it is also possible to use an indirect, arithmetical monitoring of the braking resistor load on the basis of measurement values.

This software-assisted, indirect monitoring is activated by setting parameters **P556** “*Braking resistor*” and **P557** “*Brake resistor type*”. The currently calculated resistor load can be read out in parameter **P737** “*Usage rate brakeres.*”. Overload of the braking resistor results in a shut-down of the frequency inverter with error message **E3.1** *“Overcurrent Chopper“*.

NOTICE

Overload of the braking resistor

The indirect form of monitoring based on the measurement of electrical data and calculations is based on standardised ambient conditions. In addition, the calculated values are reset when the device is switched off. It is therefore not possible to detect the actual braking resistor load.

This means that an overload may not be detected and that the braking resistor or the area around it may be damaged due to excessive temperatures.

- Use a temperature switch for safe monitoring of the braking resistor.

2.7 Chokes

Frequency inverters cause loads both on the mains side and the motor side (e.g. current harmonics, steep flanks, EMC interference), which may result in malfunctions in system operation and in the frequency inverter. Mains or link circuit chokes are primarily used for protection of the mains, motor chokes primarily reduce influences on the motor side.

2.7.1 Mains chokes

Two choke variants are available for mains protection:

- **Input chokes** are incorporated in the supply cable upstream of the inverter.
- **Link circuit chokes** are incorporated in the DC link circuit of the frequency inverter. These are smaller and lighter in weight in comparison with mains chokes.

Chokes reduce the recharging currents from the mains and the resulting harmonics. Chokes fulfil several functions:

- Reduction of the harmonics in the mains voltage upstream of the choke
- Reduction of the negative effects of mains voltage symmetries
- Increase of efficiency due to lower input current
- Increase of the service life of the link circuit capacitors

The use of chokes is recommended, for example:

- If the proportion of the installed inverter power exceeds 20% of the installed transformer power
- For very hard mains or capacitive compensation systems
- In case of large voltage fluctuations due to switching

From an inverter power of **45 kW**, the use of a **link circuit choke** is always **recommended**.

2.7.1.1 Link circuit choke SK DCL-

The link circuit choke is mounted in the immediate vicinity of the frequency inverter and connected directly to the DC link circuit of the device. All chokes have a protection class corresponding to IP00. The choke used must therefore be installed in a control cabinet.

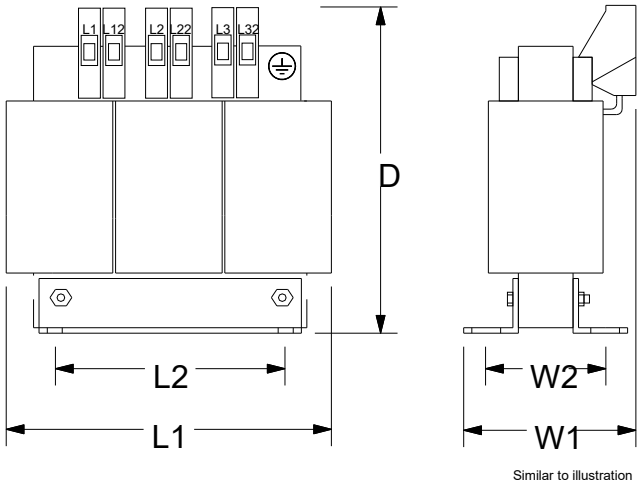
Nominal power of the frequency inverter	Filter type	Part no.	Data sheet
45 kW … 55 kW	SK DCL-950/120-C	276997120	TI 276997120
75 kW … 90 kW	SK DCL-950/200-C	276997200	TI 276997200
110 kW	SK DCL-950/260-C	276997260	TI 276997260
132 kW	SK DCL-950/320-C	276997320	TI 276997320
160 kW	SK DCL-950/380-C	276997380	TI 276997380

Table 11: Link circuit choke SK DCL-...

2.7.1.2 SK CI1 mains choke

SK CI1- chokes are specified for a maximum supply voltage of 230 V or 480 V at 50/60 Hz.

The protection class of all chokes corresponds to IP00. The choke used must therefore be installed in a control cabinet.



Similar to illustration

Inverter type SK 500E	1x 220–240 V mains choke			L1	W1	D	Detail: Fastening			Connection	Weight
	Type	Continuous current [A]	Inductivity [mH]				L2	W2	Installation		
0.25 ... 0.75 kW	SK CI1-230/8-C Part no.: 278999030	8	2 x 1.0	78	67	98	56	47.5	M4	4	1.1
1.1 ... 2.2 kW	SK CI1-230/20-C Part no.: 278999040	20	2 x 0.4	96	90	118	84	65	M6	10	2.2
All dimensions in [mm]										[mm²]	[kg]

Table 12: SK CI1-..., 1~ 240 V mains choke data

Inverter type SK 500E	3x 200–240 V mains choke			L1	W1	D	Detail: Fastening			Connection	Weight
	Type	Continuous current [A]	Inductivity [mH]				L2	W2	Installation		
0.25 ... 0.75 kW	SK CI1-480/6-C Part no.: 276993006	6	3 x 4.88	96	60	117	71	45	M4	4	0.6
1.1 ... 1.5 kW	SK CI1-480/11-C Part no.: 276993011	11	3 x 2.93	120	85	140	105	70	M4	4	2.1
2.2 … 3.0 kW	SK CI1-480/20-C Part no.: 276993020	20	3 x 1.47	155	110	177	135	95	M5	10	5.7
4.0 … 7.5 kW	SK CI1-480/40-C Part no.: 276993040	40	3 x 0.73	155	115	172	135	95	M5	10	7.5
11 … 15 kW	SK CI1-480/70-C Part no.: 276993070	70	3 x 0.47	185	122	220	170	77	M6	35	10.1
18.5 kW	SK CI1-480/100-C Part no.: 276993100	100	3 x 0.29	240	148	263	180	122	M6	35	18.4
All dimensions in [mm]										[mm²]	[kg]

Table 13: SK CI1-..., 3~ 240 V mains choke data

Inverter type SK 500E	3x 380–480 V mains choke			L1	W1	D	Detail: Fastening			Connection	Weight
	Type	Continuous current [A]	Inductivity [mH]				L2	W2	Installation		
0.55 … 2.2 kW	SK CI1-480/6-C Part no.: 276993006	6	3 x 4.88	96	60	117	71	45	M4	4	0.6
3.0 … 4.0 kW	SK CI1-480/11-C Part no.: 276993011	11	3 x 2.93	120	85	140	105	70	M4	4	2.1
5.5 … 7.5 kW	SK CI1-480/20-C Part no.: 276993020	20	3 x 1.47	155	110	177	135	95	M5	10	5.7
11 … 15 kW	SK CI1-480/40-C Part no.: 276993040	40	3 x 0.73	155	115	172	135	95	M5	10	7.5
18.5 … 30 kW	SK CI1-480/70-C Part no.: 276993070	70	3 x 0.47	185	122	220	170	77	M6	35	10.1
37 … 45 kW	SK CI1-480/100-C Part no.: 276993100	100	3 x 0.29	240	148	263	180	122	M6	35	18.4
55 … 75 kW	SK CI1-480/160-C Part no.: 276993160	160	3 x 0.18	352	140	268	240	105	M8	M8*	27.0
90 kW	SK CI1-480/280-C Part no.: 276993280	280	3 x 0.10	352	169	268	240	133	M10	M16*	40.5
110 … 132 kW	SK CI1-480/350-C Part no.: 276993350	350	3 x 0.08	352	169	268	328	118	M10	M16*	41.5
All dimensions in [mm]										[mm²]	[kg]

*Bolt for copper rails, PE: M8

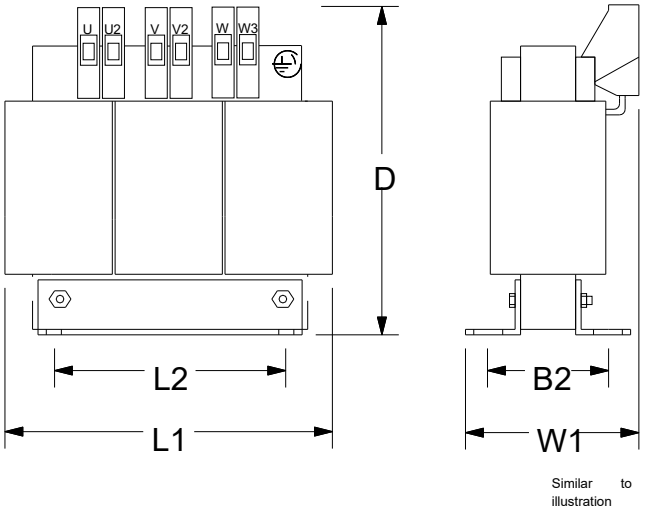
Table 14: SK CI1-..., 3~ 480 V mains choke data

2.7.2 Output choke SK CO1

To reduce interference signals from the motor cable or to compensate for cable capacitance in long motor cables, an additional output choke (motor choke) can be installed into the inverter output.

During installation take care that the pulse frequency of the frequency inverter is set to 3 - 6 kHz (P504 = 3 - 6).

These chokes are specified for a maximum supply voltage of 480 V at 0 - 100 Hz.



Similar to illustration

An output choke should be fitted for cable lengths over **100 m/30 m** (unshielded/shielded). All chokes have a protection class corresponding to **IP00.** The choke used must therefore be installed in a control cabinet.

Inverter ID SK 5xxE	Output choke 3 x200 – 240 V			L1	W1	D	Detail: Fastening			Connection	Weight
	Type	Continuous current [A]	Inductivity [mH]				L2	B2	Assembly		
0.25 … 0.75 kW	SK CO1-460/4-C Part. No.: 276996004	4	3 x 3.5	120	104	140	84	75	M6	4	2.8
1.1 ... 1.5 kW	SK CO1-460/9-C Part. No.: 276996009	9	3 x 2.5	155	110	160	130	71.5	M6	4	5.0
2.2 ... 4.0 kW	SK CO1-460/17-C Part. No.: 276996017	17	3 x 1.2	185	102	201	170	57.5	M6	10	8.0
5.5 ... 7.5 kW	SK CO1-460/33-C Part. No.: 276996033	33	3 x 0.6	185	122	201	170	77.5	M6	10	10.0
11 … 15 kW	SK CO1-480/60-C Part. No.: 276992060	60	3 x 0.33	185	112	210	170	67	M8	16	13.8
18.5 kW	SK CO1-460/90-C Part. No.: 276996090	90	3 x 0.22	352	144	325	224	94	M10	35	21.0
All dimensions in [mm]										[mm²]	[kg]

Table 15: Output choke data for SK CO1-..., 3~ 240 V

Inverter ID SK 5xxE	Output choke 3 x 380 – 480 V			L1	W1	D	Detail: Fastening			Connection	Weight
	Type	Continuous current [A]	Inductivity [mH]				L2	B2	Assembly		
0.55 ... 1.5 kW	SK CO1-460/4-C Part. No.: 276996004	4	3 x 3.5	120	104	140	84	75	M6	4	2.8
2.2 ... 4.0 kW	SK CO1-460/9-C Part. No.: 276996009	9	3 x 2.5	155	110	160	130	71.5	M6	4	5.0
5.5 ... 7.5 kW	SK CO1-460/17-C Part. No.: 276996017	17	3 x 1.2	185	102	201	170	57.5	M6	10	8.0
11 ... 15 kW	SK CO1-460/33-C Part. No.: 276996033	33	3 x 0.6	185	122	201	170	77.5	M6	10	10.0
18.5 ... 30 kW	SK CO1-480/60-C Part. No.: 276992060	60	3 x 0.33	185	112	210	170	67	M8	16	13.8
37 … 45 kW	SK CO1-460/90-C Part. No.: 276996090	90	3 x 0.22	352	144	325	224	94	M10	35	21.0
55 … 75 kW	SK CO1-460/170-C Part. No.: 276996170	170	3 x 0.13	412	200	320	264	125	M10	M12*	47.0
90 … 110 kW	SK CO1-460/240-C Part. No.: 276996240	240	3 x 0.07	412	225	320	388	145	M10	M12*	63.5
132 … 160 kW	SK CO1-460/330-C Part. No.: 276996330	330	3 x 0.03	352	188	268	328	129	M10	M16*	52.5
All dimensions in [mm]										[mm²]	[kg]

* Bolt for copper rail, PE M8

Table 16: Output choke data for SK CO1-..., 3~ 480 V

2.8 Line filter

To comply with the increased radio interference suppression class (class B according to EN 55011), an additional external line filter can be looped into the frequency inverter's mains supply cables. The internal filters of the frequency inverter must be deactivated when using a line filter. The setting of the jumpers or DIP switches then corresponds to the "Operation in IT networks" setting (see chapter 2.9.2 "Adaptation to IT networks").

2.8.1 Mains filter SK NHD (up to size 4)

SK NHD type mains filters are so-called bottom-mounted combination filters with integrated mains choke. The mains filter is only intended for three-phase operation.

This provides a compact unit to improve the level of radio interference suppression, which can also be mounted underneath the frequency inverter if there is a shortage of space.

For further information about the mains filter, please refer to the relevant data sheet. These data sheets can be downloaded from www.nord.com.

Inverter ID	Filter type	Part No.	Data sheet
SK 5xxE-250-323-A ... -750-323-A	**SK NHD-480/6-F**	278273006	TI 278273006
SK 5xxE-111-323-A ... -221-323-A	**SK NHD-480/10-F**	278273010	TI 278273010
SK 5xxE-301-323-A ... -401-323-A	**SK NHD-480/16-F**	278273016	TI 278273016
SK 5xxE-550-340-A ... -750-340-A	**SK NHD-480/3-F**	278273003	TI 278273003
SK 5xxE-111-340-A ... -221-340-A	**SK NHD-480/6-F**	278273006	TI 278273006
SK 5xxE-301-340-A ... -401-340-A	**SK NHD-480/10-F**	278273010	TI 278273010
SK 5xxE-551-340-A ... -751-340-A	**SK NHD-480/16-F**	278273016	TI 278273016

Table 17: Mains filter NHD-...

2.8.2 SK LF2 line filter (sizes 5–7)

SK LF2 line filters are footprint line filters: Their dimensions are matched to the appropriate frequency inverter. This enables space-saving installation. The data sheets are available for download at www.nord.com.

Inverter type	Filter type	Part no.	Data sheet
SK 5xxE-551-323-A … -751-323-A	**SK LF2-480/45-F**	278273045	TI 278273045
SK 5xxE-112-323-A	**SK LF2-480/66-F**	278273066	TI 278273066
SK 5xxE-152-323-A … -182-323-A	**SK LF2-480/105-F**	278273105	TI 278273105
SK 5xxE-550-340-A … -750-340-A	**SK LF2-480/2-F**	278273002	TI 278273002
SK 5xxE-111-340-A … -221-340-A	**SK LF2-480/5-F**	278273005	TI 278273005
SK 5xxE-301-340-A … -401-340-A	**SK LF2-480/9-F**	278273009	TI 278273009
SK 5xxE-551-340-A … -751-340-A	**SK LF2-480/15-F**	278273015	TI 278273015
SK 5xxE-112-340-A … -152-340-A	**SK LF2-480/45-F**	278273045	TI 278273045
SK 5xxE-182-340-A … -222-340-A	**SK LF2-480/66-F**	278273066	TI 278273066
SK 5xxE-302-340-A … -372-340-A	**SK LF2-480/105-F**	278273105	TI 278273105

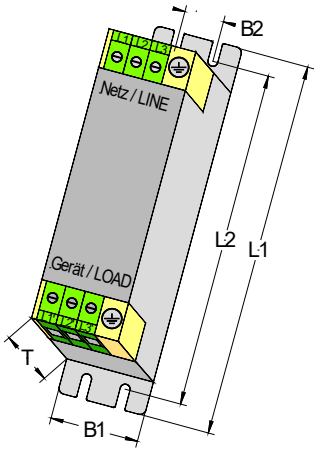
Table 18: LF2-... line filters

2.8.3 SK HLD line filter

With a chassis line filter, radio interference suppression class **B** (class C1) can be achieved up to a maximum motor cable length of 25 m.

Please note the following when connecting the line filter:

- “Wiring guidelines” (chapter 2.9.1)
- “EMC” (chapter 8.3)
- The pulse frequency is set to the default value (**P504**)
- The line filter is placed closed to (on the side of) the frequency inverter The connection is by means of screw terminals on the upper (mains) and lower (frequency inverter) ends of the filter.



Inverter type	Filter type [-V/A]	L1	W1	D	Attachment details		Cable cross-section	Data sheet
					L2	W2		
SK 5xxE-250-323-A… SK 5xxE-111-323-A [1)]	**SK HLD 110-500/8**	190	45	75	180	20	4	TI 278272008
SK 5xxE-151-323-A… SK 5xxE-221-323-A [1)]	**SK HLD 110-500/16**	250	45	75	240	20	4	TI 278272016
SK 5xxE-301-323-A… SK 5xxE-551-323-A	**SK HLD 110-500/30**	270	55	95	255	30	10	TI 278272030
SK 5xxE-751-323-A	**SK HLD 110-500/42**	310	55	95	295	30	10	TI 278272042
SK 5xxE-112-323-A	**SK HLD 110-500/75**	270	85	135	255	60	35	TI 278272075
SK 5xxE-152-323-A… SK 5xxE-182-323-A	**SK HLD 110-500/100**	270	95	150	255	65	50	TI 278272100
SK 5xxE-550-340-A… SK 5xxE-221-340-A	**SK HLD 110-500/8**	190	45	75	180	20	4	TI 278272008
SK 5xxE-301-340-A… SK 5xxE-551-340-A	**SK HLD 110-500/16**	250	45	75	240	20	4	TI 278272016
SK 5xxE-751-340-A	**SK HLD 110-500/30**	270	55	95	255	30	10	TI 278272030
SK 5xxE-112-340-A	**SK HLD 110-500/42**	310	55	95	295	30	10	TI 278272042
SK 5xxE-152-340-A… SK 5xxE-182-340-A	**SK HLD 110-500/55**	250	85	95	235	60	16	TI 278272055

Inverter type	Filter type [-V/A]	L1	W1	D	Attachment details		Cable cross-section	Data sheet
					L2	W2		
SK 5xxE-222-340-A	**SK HLD 110-500/75**	270	85	135	255	60	35	TI 278272075
SK 5xxE-302-340-A	**SK HLD 110-500/100**	270	95	150	255	65	50	TI 278272100
SK 5xxE-372-340-A… SK 5xxE-452-340-A	**SK HLD 110-500/130**	270	95	150	255	65	50	TI 278272130
SK 5xxE-552-340-A	**SK HLD 110-500/180**	380	130	181	365	102	95	TI 278272180
SK 5xxE-752-340-A… SK 5xxE-902-340-A	**SK HLD 110-500/250**	450	155	220	435	125	150	TI 278272250
SK 5xxE-113-340-A… SK 5xxE-163-340-A	**Available on request**							
				All dimensions in [mm]			In [mm²]	

1) NOTICE! The assignment of the line filter only applies to three-phase connections of the mains voltage to the frequency inverter. For single-phase connection of the mains voltage, the frequency inverter's higher input currents must be observed (see technical data).

Table 19: HLD-... line filters

Information

Use in UL-relevant areas

If the frequency inverter is used in UL-relevant areas, the line filter can be selected according to the FLA value assigned to the frequency inverter.

Example: SK 5xxE-302-340-A → Input current (RMS): **84 A / FLA: 64.1 A → HLD 110-500/75**

2.9 Electrical Connection

WARNING

Electric shock

Dangerous voltage can be present at the mains input and the motor connection terminals, even when the device is not in operation.

- Before starting work, use suitable measuring equipment to check that all relevant components (voltage source, connecting cables, connection terminals of the device) are free of voltage
- Use insulated tools (e.g. screwdrivers)
- Earth devices

NOTICE

Device failure due to increased input current

If 1-phase and 3-phase frequency inverters are operated on the same circuit, this can lead to increased input currents and corresponding faults on the 1-phase devices. You can prevent this effect through

- long mains supply cables (at least 10 m) or
- use of a mains choke before the 1-phase device.

Information

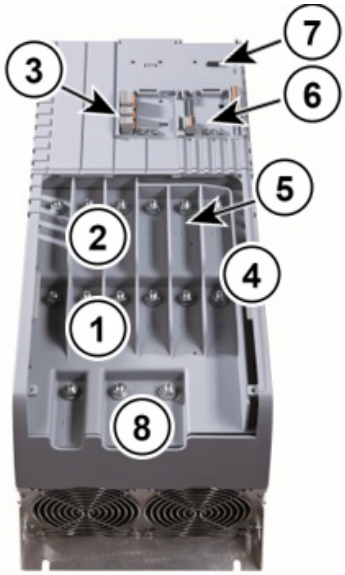
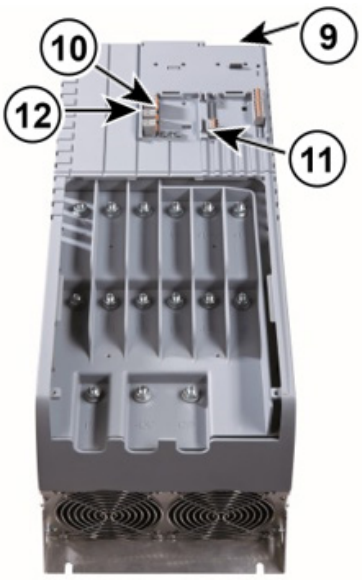
Temperature sensor and PTC resistor (TF)

As with other signal cables, PTC resistor cables must be laid separately from the motor cables. Otherwise, the interfering signals from the motor winding that are induced into the line affect the device.

Ensure that the device and the motor are specified for the correct supply voltage.

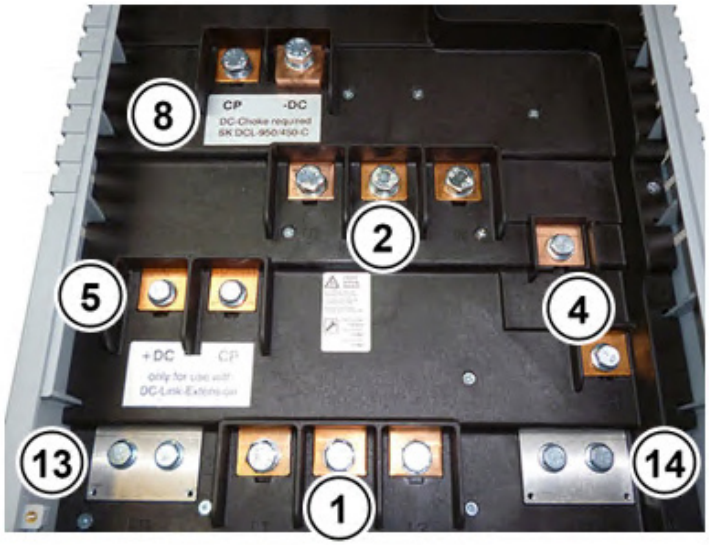
Observe the notes on long-term storage in Chapter 9.1 "Maintenance information
".

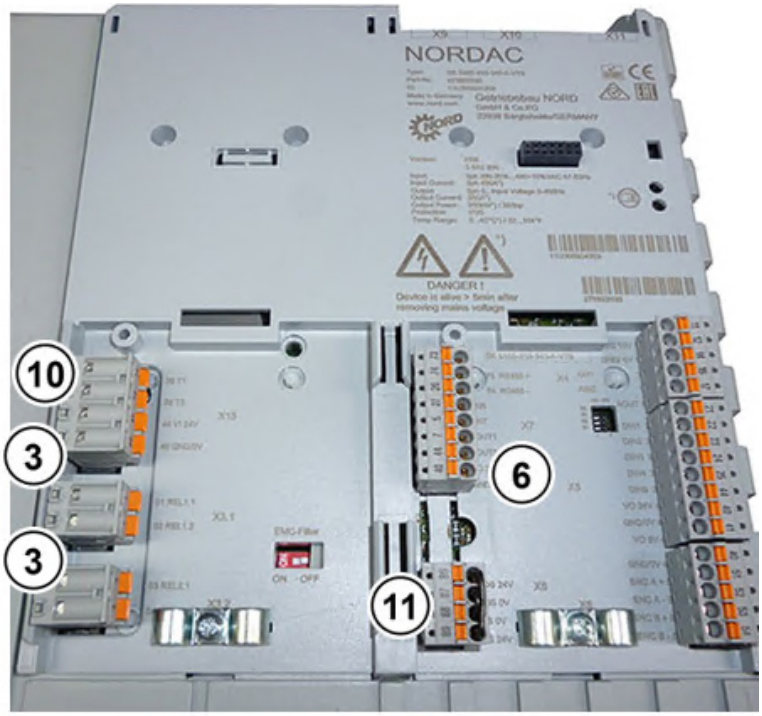
Depending on the size, the connection terminals for the power cables and the control cables are located in different positions. According to the configuration of the frequency inverter, terminals are not present.

Size 1 … 4	Size 5 … 7	Size 8, 9
		
		

1 =	Mains connection	L1, L2/N, L3, PE	X1	with size 8 and above:	X1.1, X1.2
2 =	Motor connection	U, V, W, PE	X2	with size 8 and above:	X2.1, X2.2
3 =	Test multi-function relay	1 – 4	X3		
4 =	Braking resistor	+B, -B	X2	with size 8 and above:	X30
5 =	DC link circuit	-DC	X2	with size 8 and above: +DC, -DC	X32
6 =	Control terminals	IOs, GND, 24Vout, IG, DIP for AIN	→	X4, X5, X6, X7, X14	
7 =	Technology unit				
8 =	Link circuit choke			with size 8 and above: -DC, CP, PE	X31
9 =	Communication	CAN/CANopen; RS232/RS485	→	X9/X10; X11	
10 =	Thermistor	T1/2 or TF+/-	X13	up to size 4 (except SK 54xE): on DIN 5	
11 =	Safe Pulse Block	86, 87, 88, 89	X8		
12 =	Supply voltage VI 24V	40, 44	X12	except SK 5x0E and SK 511E	

Size 10, 11





1 =	Mains connection	L1, L2, L3 (1 x M8 95 mm²)	
2 =	Motor connection	U, V, W (3 x M8 120 mm²)	
3 =	Test multi-function relay		X3.1, X3.2
4 =	Braking resistor	+B, -B (2 x M8 50 mm²)	
5 =	DC link circuit	+DC, CP (2 x M8 120 mm²)	
6 =	Control terminals		X4, X5, X6, X7
7 =	Technology unit		
8 =	Link circuit choke	CP, -DC (2x M8 120 mm²)	
9 =	Communication		X9/X10; X11
10 =	Thermistor	T1/2	X15
11 =	Safe Pulse Block	86, 87, 88, 89	X8
12 =	Supply voltage VI 24V	40, 44	X15
13 =	PE connection (e.g.)	1 x M8 95 mm2 (mains), 1 x M8 95 mm2 (choke)	
14 =	PE connection (e.g.)	1 x M8 95 mm2 (motor), 1 x M8 95 mm2 (chopper)	

2.9.1 Wiring guidelines

The devices have been developed for use in an industrial environment. In this environment, electromagnetic interference can affect the device. In general, correct installation ensures safe and problem-free operation. To meet the limiting values of the EMC directives, the following instructions should be complied with.

1. Ensure that all devices are securely earthed to a common earthing point or earthing rail using short earthing cables with a large cross-section. It is especially important that each control unit which is connected to the electronic drive technology (e.g. an automatic device) has a short cable with a large cross-section, which is connected to the same earthing point as the device itself. Flat cables (e.g. metal clamps) are preferable, as they have a lower impedance at high frequencies.
2. The bonding cable of the motor controlled by the soft starter should be connected directly to the earthing terminal of the associated device. The presence of a central earthing bar in the control cabinet and the grouping together of all bonding conductors to this bar normally ensures safe operation.
3. Where possible, shielded cables should be used for control circuits. The shielding at the cable end should be carefully sealed and it must be ensured that the wires are not laid over longer distances without shielding.

   The shielding of analogue setpoint cables should only be earthed on one side on the device.
4. Control cables should be installed as far as possible from power cables, using separate cable ducts, etc. Where cables cross, an angle of 90° should be ensured as far as possible.
5. Ensure that the contactors in the cabinet are interference protected, either by RC circuits in the case of AC contactors or by free-wheeling diodes for DC contactors, for which ***the interference suppressors must be positioned on the contactor coils***. Varistors for over-voltage limitation are also effective.

   This interference suppression is particularly important if the circuit breakers are controlled by the relay in the frequency inverter.
6. Shielded or armoured cables should be used for the load connections (motor cable). The shielding or armouring must be earthed at both ends. If possible, earthing should be made directly to the electrically conducting mounting plate of the control cabinet or the screening angle of the EMC Kit.

Furthermore, attention must be paid to the EMC-compliant wiring.

During the installation of the devices, the safety requirements must not be violated under any circumstances!

2.9.2 Adaptation to IT networks

As delivered, the inverter is configured for operation in TN or TT networks. For operation in IT networks, simple adaptations must be made. However, these impair the suppression of radio interference.

Up to and including Size 7, the adaptation is made with jumpers. As delivered, the jumpers are set in the “normal position”. With this, the mains filter has its normal effect and leakage current. Above Size 8 a DIP switch element is provided. According to the position of the DIP switch, the frequency inverter is configured for TN/TT network operation or for IT network operation (also refer to Section 8.3 and 8.3.3)

Frequency inverter	Jumper A [1]	Jumper B	Comments	Leakage current
Size 1 - 4	Position 1	Position 1	Operation in IT network	Not applicable
Size 1 - 4	Position 3	Position 2	Large filtering effect	< 30 mA
Size 1 - 4	Position 3	Position 3 [2]	Reduced filtering effect [2]	<< 30 mA > 3. mA
Size 5 - 7	Position 0	Position 1	Operation in IT network	Not applicable
Size 5 - 7	Position 4	Position 2	Large filtering effect	< 6 mA
	DIP-Switch "EMC Filter"			
Size 8 – 11	OFF		Operation in IT network	< 30 mA
Size 8 – 11	ON		Large filtering effect	< 10 mA

1) Jumper "A" is only for type SK 5xxE-…-A inverters
2) Only valid for type SK 5xxE-…-A inverters. For type SK 5xxE-…-O inverters, this jumper position is similar to position 1

Table 20: Adaptation of integrated mains filter

NOTICE

Impermissible charging of the capacitor link circuit

Destruction of the device

- Connect the braking resistor before operating the frequency inverter in the IT network. If an earth fault occurs in the IT network, this measure prevents impermissible charging of the capacitor link circuit and the resulting destruction of the frequency inverter.
- Despite connection of the braking resistor, error message “*Overvoltage Ud*” may occur. The use of the braking resistor to dissipate the charging prevents the destruction/damage of the device. However, the switching threshold for activating the brake chopper is above the fault threshold so that an error is displayed and the earth fault can be detected.
- During operation on an insulation monitor, observe the frequency inverter’s insulation resistance.

Adaptation to HRG networks

The device can also be operated in supply networks with a high-resistance earthed star point (**H**igh **R**esistance **G**rounding). These networks are common in the USA, for example. The same conditions and adjustments must be taken into account as for operation in an IT network (see above).

Adaptation of sizes 1 ... 7

NOTICE

Jumper position

Incorrect jumper positions can destroy the frequency inverter.

- Only use the jumper positions that are displayed

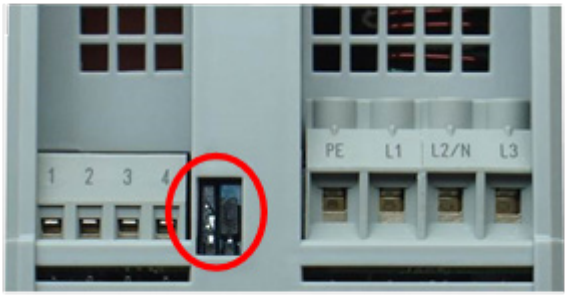
Jumper "A", mains input (only SK 5xxE-…-A devices)

Sizes 1 … 4

Operation in IT networks = Position 1

Default position = Position 3

Top of the device



Sizes 5 … 7

Operation in IT networks = Position 0

Default position = Position 4

Top of the device

Jumper "B", motor output

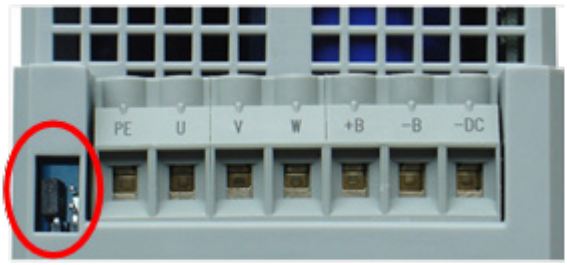
Sizes 1 … 4

Operation in IT networks = Position 1

Default position = Position 2

Reduced leakage current = Position 3
(The set pulse frequency (**P504**) has only a minor impact on the leakage current.)
(For **SK 5xxE-…-O** devices, the function is identical to position 1.)

Bottom of the device



Sizes 5 … 7

Operation in IT networks = Position 1

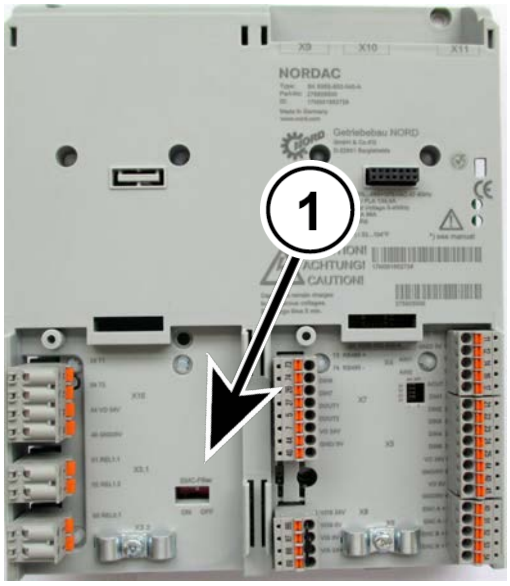
Default position = Position 2

Bottom of the device

Adaptation of size 8 and higher

The adaptation to IT networks is carried out via the DIP switch “EMC filter” (1). On delivery, this switch is in the “ON” position.

For operation in IT networks, the switch must be set to the “OFF” position. This increases the leakage current while impairing the EMC.



2.9.3 DC coupling

NOTICE

Link circuit overload

Link circuit coupling faults have negative effects on the charging circuits in the inverters and the service life of the link circuits, up to their complete destruction.

- It is essential to observe the criteria below when establishing the frequency inverter link circuit coupling.

In drive technology, DC coupling is advisable if motors simultaneously act as motors and generators in the system. The energy is then fed back from the drive that is acting as a generator to the drive that is acting as a motor. The advantages are lower energy consumption and the sparing use of braking resistors. *In principle, devices with the same power should be connected together for DC coupling wherever possible. Furthermore, only devices that are ready for operation (whose link circuits are charged) may be coupled.*

Connection

Sizes 1 … 7	+B, -DC
Size 8 and higher	+DC, -DC

NOTICE

DC coupling for single-phase devices

For DC coupling of single-phase devices, it is essential to ensure that the same external conductor is used for coupling. Otherwise, the device may be destroyed.

DC coupling is not possible with 115 V devices (SK 5xx-xxx-112-O).

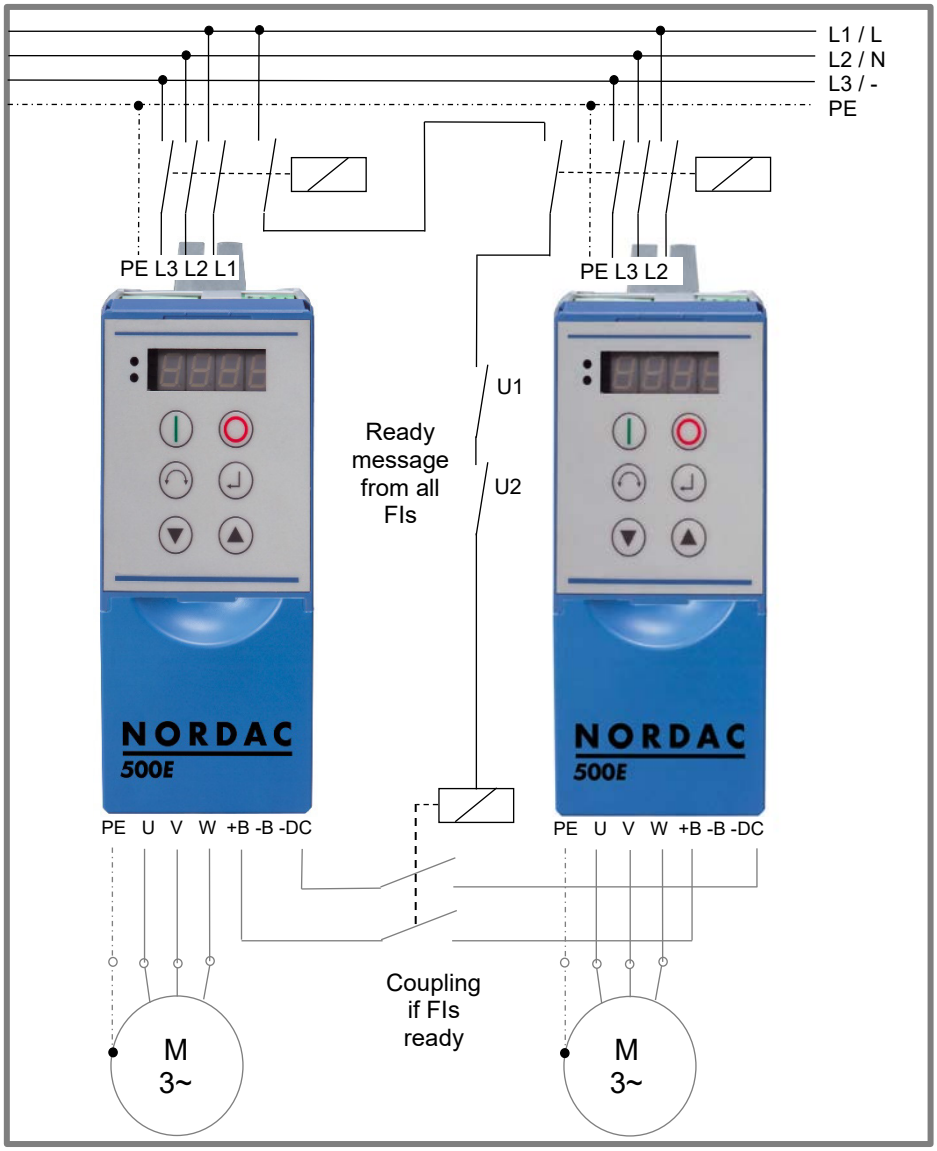


Figure 7: Illustration of a DC coupling

1. Protect the link circuits of the individual frequency inverters with suitable fuses.
2. **NOTICE!** Ensure that the coupling is only established after operational readiness is reported. Otherwise, there is a risk that all frequency inverters will be charged by only one device.
3. Ensure that the coupling is disconnected as soon as one of the devices is no longer ready for operation.
4. For high availability, a braking resistor must be used. If different sizes of frequency inverters are used, the braking resistor must be connected to the larger of the two frequency inverters.
5. If devices with the same rating (identical type) are coupled, and the same mains impedances are in effect (identical cable lengths to the mains rail), the frequency inverters may be operated without a mains choke. Otherwise, a mains choke must be installed in the mains supply cable of each frequency inverter.

2.9.4 Electrical connection of the power unit

The following information applies to all power connections on the frequency inverter. This includes:

- Mains cable connection (L1, L2/N, L3, PE)
- Motor cable connection (U, V, W, PE)
- Braking resistor connection (B+, B-)
- Link circuit connection (-DC, (+DC))
- Link circuit choke connection (-DC, CP, PE)

Ensure the following before connecting the device:

1. The voltage source supplies the correct voltage and is suitable for the current required.
2. Suitable circuit breakers with the specified nominal voltage range are installed between voltage source and frequency inverter.
3. The mains voltage is connected directly to the mains terminals L1-L2/N-L3-PE (depending on the device).
4. A four-core cable must be used to connect the motor. The cable is connected to the motor terminals PE-U-V-W.
5. If shielded motor cables are used (recommended), the cable shield must also be connected to the metal shield bracket of the EMC kit over a large surface area, but at least to the highly conductive mounting surface of the control cabinet.
6. For size 8 and higher, the tubular fork terminals included in the scope of delivery must be used. Heat shrink must be used to insulate them after crimping.

Information

Shielded cables must be used to comply with the specified radio interference suppression class.

If certain ferrules are used, the maximum connectable cable cross-section may be reduced.

The following **tools** must be used to connect the power unit:

Frequency inverter	Tool	Type
Sizes 1–4	Screwdriver	SL/PZ1; SL/PH1
Sizes 5–7	Screwdriver	SL/PZ2; SL/PH2
Sizes 8–11	Socket wrench	SW 13

Table 21: Tools

Connection data

Information

The cross-section of the connecting cables must be selected according to the expected current load and the cable fuse protection (see also “Technical data” section).

Frequency inverter	Cable Ø [mm²]		AWG	Tightening torque	
Size	Rigid	Flexible		[Nm]	[lb-in]
1 … 4	0.2 … 6	0.2 … 4	24-10	0.5 … 0.6	4.42 … 5.31
5	0.5 … 16	0.5 … 10	20-6	1.2 … 1.5	10.62 … 13.27
6	0.5 … 35	0.5 … 25	20-2	2.5 … 4.5	22.12 … 39.82
7	0.5 … 50	0.5 … 35	20-1	2.5 … 4	22.12 … 35.4
8	50	50	1/0	15	135
9	95	95	3/0	15	135
10	120	120	4/0	15	135
11	150	150	5/0	15	135

Table 22: Connection data

NOTICE

Voltage supply for brake

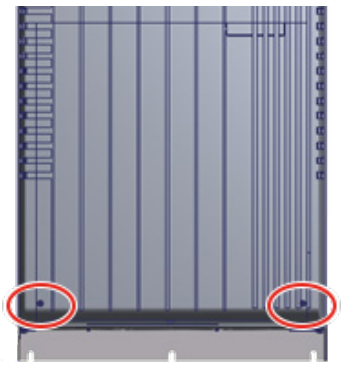
Connection to the outgoing circuit side (connection to the motor terminals) may destroy the brake and frequency inverter.

- An electro-mechanical brake (or its brake rectifiers) must be supplied with voltage from the mains.

Power connections for size 8 and higher

Use the enclosed accessories for the connections. Proceed as follows:

1. Loosen the screws and remove the cover.



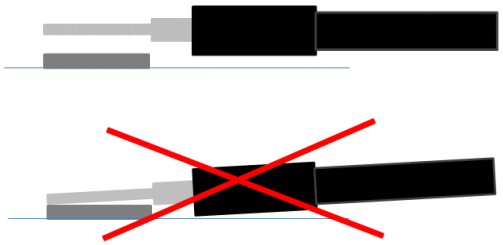
2. Install the tubular fork terminals and insulate the transitions to the connection cable with the heat shrink (scope of delivery).
3. Install the cover.

NOTICE

Fire hazard due to insufficient contacting

Particularly with cable cross-sections ≥ 120 mm², the fork terminal of the connection cable may make contact with the frequency inverter's housing. Poor contacting results in increased contact resistances. This can result in overheating and arcing at the contact points.

- Ensure that there is full surface contact.



- If necessary, fit the washer (scope of delivery) to ensure that there is full surface contact between connection cable and cable connection.

Mains connections (X1 – PE, L1, L2/N, L3)

No special safety measures are required on the mains input side of the frequency inverter. It is advisable to use the normal mains fuses (see technical data) and a main switch or circuit breaker.

Frequency inverter data		Permissible mains data			
Voltage	**Power**	**1 ~ 115 V**	**1 ~ 230 V**	**3 ~ 230 V**	**3 ~ 400 V**
115 VAC	0.25 … 0.75 kW	X			
230 VAC	0.25 … 2.2 kW		X	X	
230 VAC	≥ 3.0 kW			X	
400 VAC	≥ 0.37 kW				X
Connections		L/N = L1/L2	L/N = L1/L2	L1/L2/L3	L1/L2/L3

Isolation from or connection to the mains must always be carried out for all the poles and synchronously (L1/L2/L2 or. L1/N).

NOTICE

Damage to the FI by mains distortion

Strong mains distortions (harmonics) can lead to increased input currents and damage the rectifier in the frequency inverter.

- To prevent this, the use of mains chokes is recommended (see chapter 2.7 "Chokes").

NOTICE

Impermissible charging of the capacitor link circuit

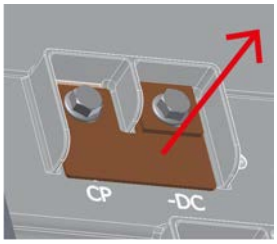
Destruction of the device

- Connect the braking resistor before operating the frequency inverter in the IT network. If an earth fault occurs in the IT network, this measure prevents impermissible charging of the capacitor link circuit and the resulting destruction of the frequency inverter.
- Despite connection of the braking resistor, error message "*Overvoltage Ud*" may occur. The use of the braking resistor to dissipate the charging prevents the destruction/damage of the device. However, the switching threshold for activating the brake chopper is above the fault threshold so that an error is displayed and the earth fault can be detected.
- During operation on an insulation monitor, observe the frequency inverter's insulation resistance.

Connecting a link circuit choke for size 8 and higher

Use the parts enclosed in the scope of delivery. Proceed as follows:

1. Remove the bridge.
2. Fit a square washer to the "-DC" connection.



Motor cable (X2 – U, V, W, PE)

The motor cable may have a **total length of 100 m** if it is a standard cable type (observe EMC). If a shielded motor cable is used or if the cable is installed in a metallic and well-grounded duct, the **total length should not exceed 30 m**.

An additional motor choke (accessory) must be used for longer cables.

For multiple-motor operation, the total motor cable length is the sum of the individual motor cable lengths.

NOTICE

Output switching

Damage to the frequency inverter

- Do not switch the motor cable while the frequency inverter is pulsing. The frequency inverter must be set to "Ready to switch-on" or "Switch-on inhibit".

Braking resistor (X2 – +B, -B; size 8 and higher: X30)

Terminals +B/-B are intended for the connection of a suitable braking resistor. A short, shielded connection should be selected. When installing a braking resistor, very high operating temperatures (> 70 °C) must be taken into account.

2.9.5 Electrical connection of the control unit

The control connections are located below the frequency inverter's front cover (size 8 and higher: below the two front covers). The equipment varies depending on the version and size. Up to size 7, individual control terminals (X3, X8, X13) are positioned remotely (see chapter 2.9 "Electrical Connection").

Connection data:

Frequency inverter		**All**	**Sizes 1 … 4**	**Sizes 5 … 7**	**Size 8 and higher**
Terminal block		**Typical**	**X3**	**X3, X8, X12, X13**	**X3.1/2, X15**
Rigid cable Ø	[mm²]	0.14 … 1.5	0.14 … 2.5	0.2 … 6	0.2 … 2.5
Flexible cable Ø	[mm²]	0.14 … 1.5	0.14 … 1.5	0.2 … 4	0.2 … 2.5
AWG standard		26-16	26-14	24-10	24-12
Tightening torque	[Nm]	Clamping	0.5 … 0.6	0.5 … 0.6	Clamping
	[lb-in]		4.42 … 5.31	4.42 … 5.31	

GND/0 V is a common reference potential for analogue and digital inputs.

It must also be noted that for **SK 5x5E** frequency inverters of sizes 1 ... 4, terminal 44 is used to supply control voltage; for devices of size 5 and higher, this terminal provides 24 V control voltage.

Information

Total currents

5 V / 15 V (24 V) can be obtained from several terminals if required. This also includes digital outputs or a control module connected via RJ45, for example.

For sizes 1 … 4, the total output current must not exceed 250 mA / 150 mA (5 V / 15 V). For size 5 and higher, the limit values are 250 mA / 200 mA (5 V / 24 V).

Information

Cable laying

All control cables (including thermistors) must be routed separately from the mains and the motor cables to prevent interference in the device.

If the cables are routed in parallel, a minimum distance of 20 cm must be maintained from cables which carry a voltage of > 60 V. The minimum distance may be reduced by screening the cables which carry a voltage, or by the use of earthed metal partitions within the cable conduits.

Alternatively: Use a hybrid cable with shielding of the control lines.

X3 terminal block (for size 8 and higher: X3.1 and X3.2) – relay

NOTICE

Cancellation of the safety function

If a relay contact is integrated into a circuit with safe isolation and dangerous potential (≥ 60 V AC) is applied to this relay, the safety function of the circuit is cancelled.

- Do not apply dangerous potential to the relays (≥ 60 V AC) if one contact of the relay is in a circuit with safe isolation.

Relevance	SK 540E	SK 545E
	√	√

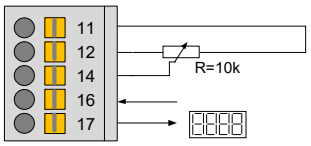
X3 terminals:	1	2	3	4
Designation	K1.1	K1.2	K2.1	K2.2

Terminal	Function [factory setting]	Data	Description / circuit proposal	Parameter
1.1 2.1	Output 1 [brake control]	*Relay contact:* normally open [AC-31B, DC-31] 230 V AC, 24 V DC, ≤ 2 A (ohmic, inductive with freewheeling) *Circuits with safe isolation [SELV, PSELV]:* Output 1 / output 2: max. 25 V AC / 30 V DC – both circuits are safely isolated! *Layout design:* 3 mm basic isolation to PE / 1.5 mm basic isolation between the switching contacts (output 1 and output 2)	Brake control (applied upon enable)	P434 [-01]
2.1 2.2	Output 2 [ready/fault]		Fault / ready for operation (is applied when Inverter ready / no error)	P434 [-02]

Terminal block X4 – Analog I/O

Relevance	SK 540E	SK 545E
	√	√

Terminals X4:	11	12	14	16	17
Name	VO 10V	GND/0V	AIN1	AIN2	AOUT1

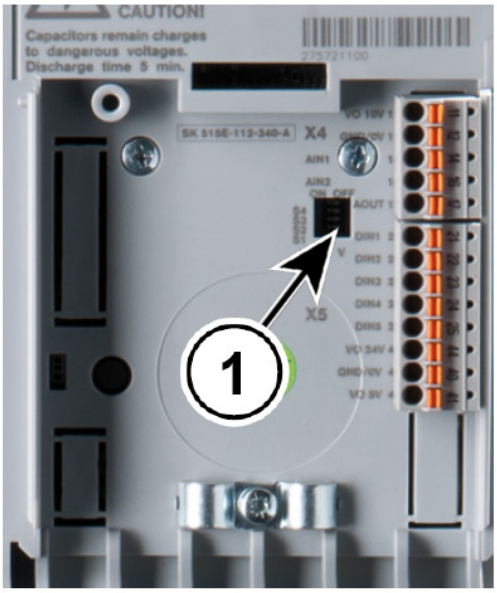
Terminal	Function [factory setting]	Data	Description / wiring suggestion	Parameter
11	10V Reference voltage	10V, 5mA, not short-circuit resistant	The analog input controls the output frequency of the frequency inverter.  The possible digital functions are described in Parameter P420. Size 5 and above: Configuration of analog input with DIP switch (see below)	
12	Reference potential for analog signals	0V analog		
14	Analog input 1 [set point frequency]	V=0...10V, R_i=30kΩ, I=0/4...20mA, R_i=250Ω, can be switched over with DIP switch, reference voltage GND. For the use of digital functions 7.5...30V. Size 5 and above: also -10 … + 10 V signals		P400 [-01] P420 [-08]
16	Analog input 2 [no function]			P400 [-02] P420 [-09]
17	Analog output [no function]	0...10V Reference potential GND Max. load current: 5mA analog, 20mA digital	Can be used for an external display or for further processing in a following machine.	P418 [-01]

Analog signal configuration

Size 1 … 4

1 = DIP switch: left = I / right = V

AIN2:	I	= Current 0/4 … 20 mA
	V	= Voltage
AIN1:	I	= Current 0/4 … 20 mA
	V	= Voltage



Size 5 and above:

1 = DIP switch: left = ON / right = OFF

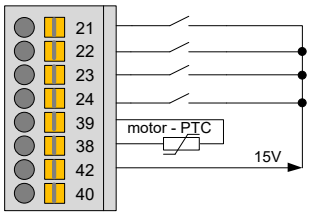
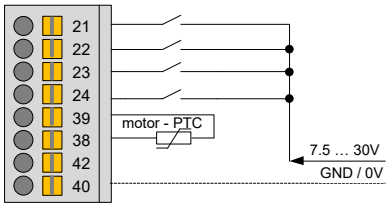
S4:	**AIN2:**	ON	= ± 10 V
		OFF	= 0 … 10 V
S3:	**AIN1:**	ON	= ± 10 V
		OFF	= 0 … 10 V
S2:	**AIN2:**	I	= ON = current 0/4...20 mA
		V	= OFF = voltage
S1:	**AIN1:**	I	= ON = current 0/4...20 mA
		V	= OFF = voltage

Note:
If S2 = ON (AIN2 = Current input), S4 must be = OFF.
If S1 = ON (AIN1 = Current input), S3 must be = OFF.

Terminal block X5 – Digital In

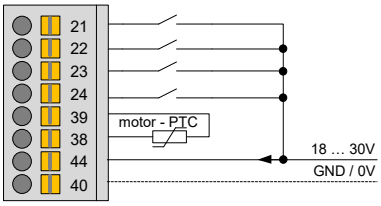
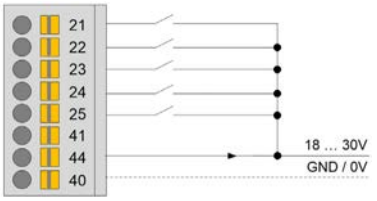
Relevance	SK 540E	SK 545E
	√	

X5 terminals:	21	22	23	24	39	38	42	40
Designation	DIN1	DIN2	DIN3	DIN4	TF-	TF+	VO 15 V	GND/0 V

Terminal	Function [factory setting]	Data	Description / circuit proposal	Parameter
21	Digital input 1 [ON right]	7.5 ... 30 V, R_i = 6.1 kΩ **Not** suitable for PTC resistor evaluation HTL encoders can only be connected to DIN2 and DIN4 Cut-off frequency: max. 10 kHz	Each digital input has a response time of ≤ 5 ms. Control with internal 15 V:  Control with external 7.5–30 V: 	P420 [-01]
22	Digital input 2 [ON left]			P420 [-02]
23	Digital input 3 [Parameter set bit0]			P420 [-03]
24	Digital input 4 [Fixed frequ. 1, **P429**]			P420 [-04]
39	PTC resistor input -	Electrically isolated PTC resistor input that cannot be switched off for monitoring the motor temperature via PTC		
38	PTC resistor input +			
42	15 V supply voltage **(output)**	15 V ± 20% Max. 150 mA (output), short-circuit-protected	Voltage supply provided by the FI to control the digital inputs or to supply a 10–30 V encoder	
40	Reference potential of digital signals	0 V digital	Reference potential	

Relevance	SK 540E	**SK 545E**
		√

X5 terminals:	**21**	**22**	**23**	**24**	**25/39**	**41/38**	**44***	**40**	*Terminal 44: Up to size 4: VI Size 5 and higher: VO
Designation	DIN1	DIN2	DIN3	DIN4	DIN5 / TF-	VO 5 V / TF+	V … 24 V	GND/0 V	

Terminal	Function [factory setting]	Data	Description / circuit proposal	Parameter
21	Digital input 1 [ON right]	7.5 … 30 V, R_i = 6.1 kΩ **Not** suitable for PTC resistor evaluation HTL encoders can only be connected to DIN2 and DIN4 Cut-off frequency: max. 10 kHz	Each digital input has a response time of ≤ 5 ms. <u>Sizes 1–4:</u>  <u>Size 5 and higher:</u> 	P420 [-01]
22	Digital input 2 [ON left]			P420 [-02]
23	Digital input 3 [Parameter set bit0]			P420 [-03]
24	Digital input 4 [Fixed frequ. 1, **P429**]			P420 [-04]
25	Digital input 5 [No function]	*Available for size 5 and higher*		P420 [-05]
39	PTC resistor input -	*Available for sizes 1–4* Electrically isolated PTC resistor input that cannot be switched off for monitoring the motor temperature via PTC		
38	PTC resistor input +			
41	5 V supply voltage **(output)**	*Available for size 5 and higher* 5 V ± 10% Max. 250 mA (output), not short-circuit-protected		
44	<u>Sizes 1–4</u> **VI 24 V** voltage supply **(input)**	18 … 30 V Min. 800 mA (input)	Voltage supply for the FI control unit. It is essential for the functioning of the FI.	
	<u>Size 5 and higher</u> **VO 24 V** voltage supply **(output)**	24 V ± 25% Max. 200 mA (output), short-circuit-protected	Voltage supply provided by the FI to control the digital inputs or to supply a 10–30 V encoder 24 V DC control voltage is generated by the FI itself but can alternatively be supplied via the X12:44/40 terminals (from size 8: X15:44/40). Supply via terminal X5:44 is not possible.	
40	Reference potential of digital signals	0 V digital	Reference potential	

Terminal block X6 – Encoder

Relevance	SK 540E	SK 545E
	√	√

Terminals X6:	49	51	52	53	54
Name	VO 12V	ENC A+	ENC A-	ENC B+	ENC B-

Terminal	Function [factory setting]	Data	Description / wiring suggestion	Parameter
49	12V supply voltage **output**	12V ± 20% max. 150mA not short-circuit resistant	The incremental encoder input can be used for the exact regulation of speed of rotation, additional set point functions or positioning. An encoder system with 10-30V supply voltage must be used in order to compensate for voltage drop in long cable connections. **Note:** Encoders with 5V supply are not suitable for setting up a system which operates reliably.	
51	Track A	TTL, RS422 500…8192Imp./Rpm. Limit frequencies: max. 205 kHz		P300
52	Track A inverse			
53	Track B			
54	Track B inverse			

X7 terminal block – digital I/O

Relevance	**SK 540E** SK 545E √

X7 terminals:	**73**	**74**	**26**	**27**	**5**	**7**	**42**	**40**
Designation	RS485+	RS485-	DIN6	DIN7	DOUT1	DOUT2	VO 15 V	GND/0 V

Terminal	Function [factory setting]	Data	Description / circuit proposal	Parameter
73 74	RS485 data cable	Baud rate: 9600 … 38400 baud Terminating resistor R = 240 Ω	BUS connection, parallel to RS485 to RJ12 plug **NOTE:** The DIP switch 1 terminating resistor (see RJ12/RJ45) must also be used for terminal 73/74.	P503 P509
26	Digital input 6 [no function]	7.5 ... 30 V, R_i = 3.3 kΩ	As described for X5 terminal block and DIN1 to DIN5. Not suitable for evaluating a motor PTC resistor.	P420 [-06]
27	Digital input 7 [no function]			P420 [-07]
	Alternatively: Output 5 (DOUT3) [no function]	Digital output 15 V, max. 20 mA With inductive loads: Provide protection via free-wheeling diode.	The digital input (DIN7) can also be used as a digital output (DOUT3). If **P434 [-05]** and **P420 [-07]** are parameterised with functions, a High signal of the DOUT function leads to a High signal for the DIN function.	P434 [-05]
5	Output 3 (DOUT1) [no function]		For evaluation in a control unit. The functional scope corresponds to that of the relays (**P434**).	P434 [-03]
7	Output 4 (DOUT2) [no function]			P434 [-04]
	Alternatively: Digital input 8 [no function]	7.5 ... 30 V, R_i = 3.3 kΩ	The digital output (DOUT2) can also be used as a digital input (DIN8). If **P434 [-04]** and **P420 [-10]** are parameterised with functions, a High signal of the DOUT function leads to a High signal for the DIN function.	P420 [-10]
42	15 V supply voltage **(output)**	15 V ± 20% Max. 150 mA (output), short-circuit-protected	Voltage supply to control the digital inputs or to supply a 10–30 V encoder	
40	Reference potential of digital signals	0 V digital		

Relevance	SK 540E	**SK 545E**
		√

X7 terminals:	**73**	**74**	**26**	**27**	**5**	**7**	**44***	**40**	*Terminal 44: Up to size 4: VI Size 5 and higher: VO
Designation	RS485+	RS485-	DIN6	DIN7	DOUT1	DOUT2	V … 24 V	GND/0 V	

Terminal	Function [factory setting]	Data	Description / circuit proposal	Parameter
73 74	RS485 data cable	Baud rate: 9600 … 38400 baud Terminating resistor R = 240 Ω	BUS connection, parallel to RS485 to RJ12 plug **NOTE:** The DIP switch 1 terminating resistor (see RJ12/RJ45) must also be used for terminal 73/74.	P503 P509
26	Digital input 6 [no function]	7.5 ... 30 V, R_i = 3.3 kΩ	As described for X5 terminal block and DIN1 to DIN5. Not suitable for evaluating a motor PTC resistor.	P420 [-06]
27	Digital input 7 [no function]			P420 [-07]
	Alternatively: Output 5 (DOUT3) [no function]	Digital output <u>Sizes 1–4</u> 18–30 V, depending on VI 24 V, max. 20 mA <u>Size 5 and higher</u> **DOUT1 and DOUT2:** 24 V, max. 200 mA With inductive loads: Provide protection via free-wheeling diode.	The digital input (DIN7) can also be used as a digital output (DOUT3). If **P434 [-05]** and **P420 [-07]** are parameterised with functions, a High signal of the DOUT function leads to a High signal for the DIN function.	P434 [-05]
5	Output 3 (DOUT1) [no function]		For evaluation in a control unit. The functional scope corresponds to that of the relays (**P434**).	P434 [-03]
7	Output 4 (DOUT2) [no function]			P434 [-04]
	Alternatively: Digital input 8 [no function]	7.5 ... 30 V, R_i = 3.3 kΩ	The digital output (DOUT2) can also be used as a digital input (DIN8). If **P434 [-04]** and **P420 [-10]** are parameterised with functions, a High signal of the DOUT function leads to a High signal for the DIN function.	P420 [-10]
44	<u>Sizes 1–4</u> **VI 24 V** voltage supply **(input)**	18 … 30 V Min. 800 mA (input)	Voltage supply for the FI control unit. It is essential for the functioning of the FI.	
	<u>Size 5 and higher</u> **VO 24 V** voltage supply **(output)**	24 V ± 25% Max. 200 mA (output), short-circuit-protected	Voltage supply provided by the FI to control the digital inputs or to supply a 10–30 V encoder 24 V DC control voltage is generated by the FI itself but can alternatively be supplied via the X12:44/40 terminals. Supply via terminal X7:44 is not possible.	
40	Reference potential of digital signals	0 V digital		

Terminal block X8 – Safe pulse lock (not with 115V devices)

Relevance	**SK 540E** SK 545E √			
Terminal X8:	**86**	**87**	**88**	**89**
Designation	VO_S 15V	VO_S 0V	VI_S 0V	VI_S 24V

Terminal	Function [factory setting]	Data	Description / wiring suggestion	Parameter
86	Supply voltage	Not short circuit resistant Details: BU0530, “Technical data”	When setting-up without using a safety function, wire directly to V_IS 24V.	P420 [-…]
87	Reference potential			
88	Reference potential	Details: BU0530, “Technical data”	Fail-safe input	
89	Input 'Safe Pulse Block'			

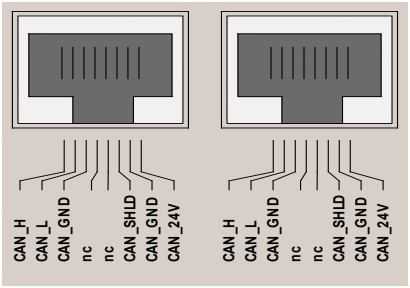
Relevance	SK 540E **SK 545E** √			
Terminal X8:	**86**	**87**	**88**	**89**
Designation	VO_S 24V	VO_S 0V	VI_S 0V	VI_S 24V

Terminal	Function [factory setting]	Data	Description / wiring suggestion	Parameter
86	Supply voltage	Not short circuit resistant Details: BU0530, “Technical data”	When setting-up without using a safety function, wire directly to V_IS 24V.	P420 […]
87	Reference potential			
88	Reference potential	Details: BU0530, “Technical data”	Fail-safe input	
89	Input 'Safe Pulse Block'			

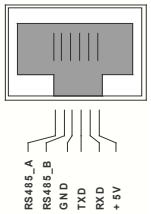
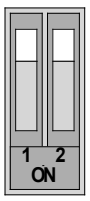
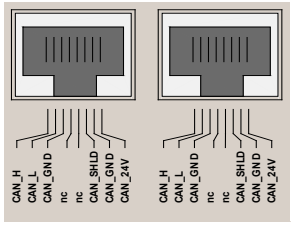
X9 and X10 connector blocks – CAN/CANopen

Relevance	SK 540E	SK 545E
	√	√

X9 / X10 terminals:	1	2	3	4	5	6	7	8
Designation	CAN_H	CAN_L	CAN_GND	nc	nc	CAN_SHD	CAN_GND	CAN_24V

Contact	Function [factory setting]	Data	Description / circuit proposal	Parameter
1	CAN/CANopen signal	Baud rate … 500 kbaud RJ45 sockets are connected in parallel internally. Terminating resistor R = 120 Ω DIP 2 (see below) **NOTES:** • 24 V must be supplied externally to operate the CANbus/CANopen interface (capacity of at least 30 mA). • Do not connect the cable shield directly to PE, but connect it capacitively.	X10 X9  2x RJ45: Pin No. 1… 8 **NOTE:** This CANopen interface can be used to evaluate an absolute encoder. Further details can be found in manual BU 0510. Recommendation: Implement strain relief (for example with EMC kit)	P503 P509
2				
3	CAN GND			
4	No function			
5				
6	Cable shield			
7	GND/0 V			
8	Ext. 24 V DC voltage supply			

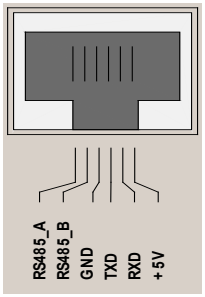
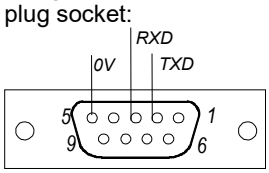
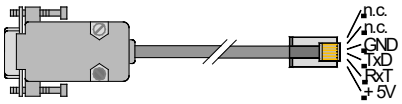
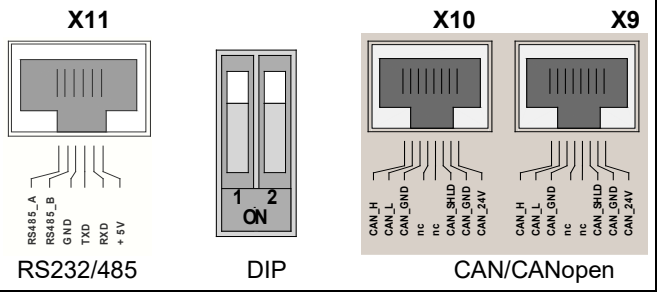
DIP switch 1/2 (top of the frequency inverter)

DIP-1	Terminating resistor for RS485 interface (RJ12); ON = switched in [Default = “OFF”] For RS232 communication: DIP1 to “**OFF**”	X11  RS232/485
DIP-2	Terminating resistor for CAN/CANopen interface (RJ12); ON = switched in [Default = “OFF”]	 DIP
		X10 X9  CAN/CANopen

Plug connector block X11 – RS485 / RS232

Relevance	SK 540E	SK 545E
	√	√

Terminals X11:	1	2	3	4	5	6
Name	RS485 A +	RS485 A-	GND	232 TXD	232 RXD	+5V

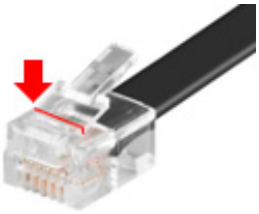
Contact	Function [factory setting]	Data	Description / wiring suggestion	Parameter
Note: Coupling of two frequency inverters via the RJ12 socket must only be made via the USS BUS (RS485). Care must be taken that no connection to the data cable **is possible via RS232**, in order to prevent damage to this interface.				
1 2	Data cable RS485	Baud rate 9600…38400 Baud Terminal resistance R=240 Ω DIP 1 (see below)	 RJ12: Pin No. 1 … 6	P503 P509
3	Reference potential for bus signals (must always be wired!)	0 V digital		
4 5	Data cable RS232	Baud rate 9600…38400Baud		
6	Internal 5V supply voltage	5 V ± 20 %		
optional	Adapter cable RJ12 to SUB-D9 for RS232 communication for direct connection to a PC with NORD CON	Length 3 m Assignment of the SUB-D9 plug socket: 	 Part No. 278910240	
DIP switch 1/2 (top side of frequency inverter)				
DIP-1	Termination resistor for RS485 interface (RJ12); ON = switched in [Default = "OFF"] For RS232 communication DIP1 to "**OFF**"		 RS232/485 DIP CAN/CANopen	
DIP 2	Terminal resistor for CAN/CANopen interface (RJ12); ON = switched in [Default = "OFF"]			

Information

Use RJ12 plugs without latching tab

Only use RJ12 plugs without latching tab for connection to the diagnostic interface (RJ12 socket). Otherwise, the plug may get jammed in the RJ12 socket.

If necessary, remove the latching tab according to the figure and make sure that no burr remains.



Terminal block X12 – 24 V DC input (only sizes 5 … 7)

Relevance	SK 540E	SK 545E
		√

X12 terminals:	40	44
Designation	GND	VI 24 V

Terminal	Function [factory setting]	Data	Description / circuit proposal	Parameter
44	Voltage supply **(input)**	24 V … 30 V Min. 1000 mA **NOTE**: This input is not protected against polarity reversal.	Connection is optional. If no control voltage is connected, the control voltage can be generated via an internal power supply unit.	
40	Reference potential of digital signals	GND/0 V	Reference potential	

Terminal block X13 – motor PTC (only size 5 … 7)

Relevance	SK 540E	SK 545E
		√

Terminals X13:	T1	T2
Name	T1	T1

Terminal	Function [factory setting]	Data	Description / wiring suggestion	Parameter
T1	Thermistor input +	EN 60947-8 On: >3.6 kΩ Off: < 1.65 kΩ Measurement voltage 5 V at R < 4 kΩ	The function cannot be switched off, set a jumper if no PTC is present.	
T2	Thermistor input -			

Terminal block X14 – Universal encoder interface

Relevance	SK 540E	SK 545E
	√	√

Terminals X14:	66	65	64	63
Designation	DAT-	DAT+	CLK-	CLK+

Terminal	Function [factory setting]	Data	Description / wiring suggestion	Parameter
66	Signal DAT- (RS485 DAT-)	TTL, RS422 Communication frequency 200 kHz, Exception for SSI encoder: 100 kHz	For the connection of SSI, BISS, EnDat and Hiperface encoders.	P300, (P604, however only for POSICON)
65	Signal DAT+ (RS485 DAT+)			
64	Signal CLK-		For the connection of SSI, BISS and EnDat encoders. *Alternative:* if *no* universal encoder is connected: Connection for the zero track of a universal encoder: ***0 → 63***, ***0/ → 64*** possible.	
63	Signal CLK+			

X15 terminal block – motor PTC and 24 V input (size 8 and higher)

Relevance	SK 540E	SK 545E
		√

X15 terminals:	38	39	44	40
Designation	T1	T2	VI 24 V	GND

Terminal	Function [factory setting]	Data	Description / circuit proposal	Parameter
38	PTC resistor input +	EN 60947-8 On: > 3.6 kΩ Off: < 1.65 kΩ Measurement voltage: 5 V on R < 4 kΩ	Function cannot be switched off; set a bridge if there is no PTC resistor.	
39	PTC resistor input -			
44	Voltage supply **(input)**	24 V … 30 V Min. 3000 mA **NOTE**: This input is not protected against polarity reversal.	Connection is optional. If no control voltage is connected, the control voltage can be generated via an internal power supply unit.	
40	Reference potential of digital signals	GND/0 V	Reference potential	

Encoder connection

The incremental encoder connection is an input for a type with two tracks and TTL-compatible signals for EIA RS 422-compliant drivers. The maximum current consumption of the incremental encoder must not exceed 150 mA.

The pulse number per revolution can be between 500 and 8192 increments. This is set in common increments via parameter **P301** “Incremental encoder” in the “Control parameters” menu group. For cable lengths > 20 m and motor speeds above 1500 rpm, the encoder should not have more than 2048 pulses/revolution.

For longer cable lengths, the cable cross-section must be selected large enough so that the voltage drop in the cables is not too great. This particularly affects the supply cable, in which the cross-section can be increased by connecting several wires in parallel.

In contrast to incremental encoders, the signals for *sine encoders* or *SIN/COS encoders* are not output in the form of pulses but in the form of two sine signals (offset by 90°).

Information

Encoder signal faults

Unrequired wires (for example track A inverse / B inverse) must be insulated. Otherwise, if these wires come into contact with each other or the cable shield, short circuits may occur, which can cause encoder signal faults or encoder damage.

Information

Direction of rotation

The incremental encoder’s counting direction must correspond to the motor’s direction of rotation. If the two directions are not identical, the connections of the encoder tracks (track A and track B) must be switched. Alternatively, the resolution (pulse number) of the encoder in can be set with a negative sign in parameter **P301**.

Incremental encoder

According to the resolution (pulse number), incremental encoders generate a defined number of pulses for each rotation of the encoder shaft (Track A / Track A inverse) With this, the precise speed of the encoder or motor can be measured by the frequency inverter. By using a second track (B / B inverse) shifted by 90° (¼ period), the direction of rotation can also be determined.

The supply voltage for the encoder is 10 … 30 V. An external voltage source or the internal voltage can be used as the voltage source (depending on the frequency inverter version: 12 V /15 V / 24 V).

Special terminals are available for connection of a rotary encoder with TTL signals. Parameterisation of the corresponding functions is done with the parameters from the “Control parameters” group (P300 et seq.). TTL encoders enable the best performance for control of a drive with frequency inverters SK 520E and higher.

The digital inputs DIN 2 and DIN 4 are used to connect an encoder with HTL signal. The corresponding functions are parameterised with parameters P420 [-02/-04] or P421 and P423 as well as P461 … P463. In comparison with the TTL encoder, HTL encoders enable restricted speed control performance (lower limit frequencies). They can be used with a considerably lower resolution and also with SK 500E.

Function	Cable colours for incremental encoder	Signal type TTL		Signal type HTL	
		SK 5xxE assignment Terminal bar X5 or X6			
10-30 V supply	Brown / green	**42(/44/49)**	15 V (/24 V/12 V)	**42(/44/49)**	15 V (/24 V/12 V)
0 V supply	White / green	**40**	GND/0 V	**40**	GND/0 V
Track A	Brown	**51**	ENC A+	**22**	DIN2
Track A inverse	Green	**52**	ENC A-	-	-
Track B	Grey	**53**	ENC B+	**24**	DIN4
Track B inverse	Pink	**54**	ENC B-	-	-
Track 0	Red	**X14: 63**	CLK+	-	-
Track 0 inverse	Black	**X14: 64**	CLK-	-	-
Cable shield	Connect to a large area of the frequency inverter housing or shielding bracket				

Table 23: Colour and contact assignments for NORD – TTL/HTL incremental encoder

Information

Incremental encoder data sheet

If the equipment deviates from the standard equipment for the motors (Type 5820.0H40, 10 … 30 V encoder, TTL/RS422 or encoder type 5820.0H30, 10 … 30 V encoder, HTL), please note the accompanying data sheet or consult your supplier.

Information

Zero track connection (SK 54xE)

The zero track of an incremental encoder can only be evaluated if the universal encoder interface (X14) is not occupied by a universal encoder. (→ **P335**)

Sinus encoder (SIN/COS encoder)

The use or function of sine encoders is comparable with that for incremental encoders. However, the encoder provides sine wave signals instead of digital pulses.

The supply voltage for the encoder is 10-30V. The voltage source can be an external source or the internal voltage (according to the frequency inverter version: 12V /15V /24V).

Function	Cable colours for Sin/Cos encoder*	Assignment for SK 54xE Terminal block X5 or X6
10-30V supply	brown	**42**(/**44** /**49**) 15V (/24V /12V)
0V supply	white	**40** GND/0V
Track A	green	**51** ENC A+
Track A inverse	yellow	**52** ENC A-
Track B	grey	**53** ENC B+
Track B inverse	pink	**54** ENC B-
Cable shield	connected to a large area of the frequency inverter housing or shielding angle	
* E.g. Kübler 5824		

Table 24: Colour and contact assignment for SIN/COS encoders

Function	Signal designation	Signal voltage
Sine signal	Sin	max. 5V U_{ss}
Cosine signal	Cos	max. 5V U_{ss}

Table 25: Signal details for SIN/COS encoders

Hiperface encoders

Hiperface represents a mixture of incremental encoder and absolute encoder, and combines the advantages of both encoder types. Initially, the absolute value is only generated when the device is switched on and it is communicated to the external counter in the controller via the bus-enabled parameter interface with RS485 specification. From this absolute value, counting is then continued incrementally with the analogue sine/cosine signals. During operation, the counted position is continuously compared with the measured absolute position of the encoder.

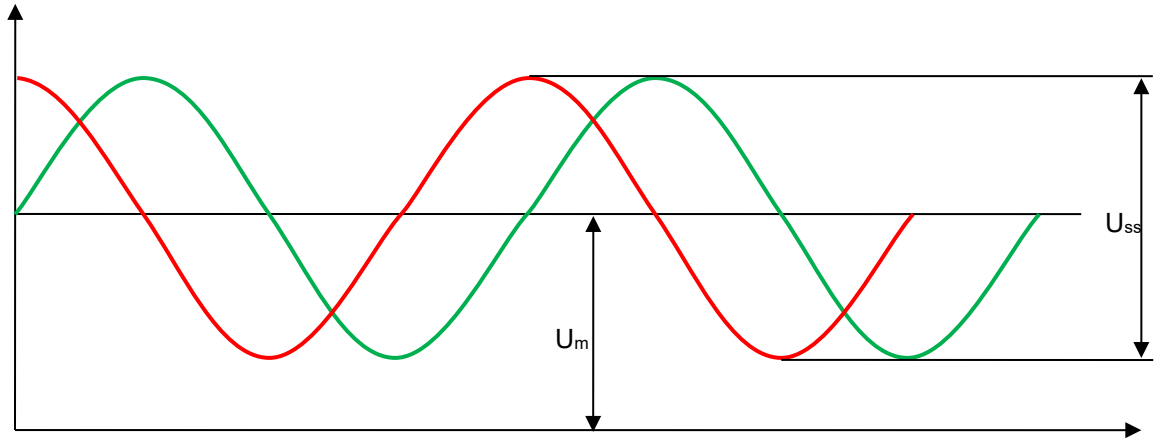
Hiperface encoders are suitable for positioning in combination with the servo mode.

The requirements for the analogue signal are shown in the following table. It should be noted that voltage tolerances have an effect on the accuracy of the determined position.

The supply voltage for the encoder is 7 … 12 V. An external source or the internal 12 V voltage can be used as the voltage source.

Function	Signal designation	Signal voltage
Sine reference voltage	Sin Ref	2.5 V U_m
Cosine reference voltage	Cos Ref	2.5 V U_m
Sine signal	Sin	1 V U_{ss}
Cosine signal	Cos	1 V U_{ss}

Table 26: Hiperface encoder signal details



Function	Cable colours for Hiperface encoder	SK 54xE assignment Terminal bar X5, X6 or X14
7-12 V supply	Red	49 VO 12 V
0 V supply	Blue	40 GND/ 0V
+ SIN	White	51 ENC A+
REFSIN	Brown	52 ENC A-
+ COS	Pink	53 ENC B+
REFCOS	Black	54 ENC B-
Data + (RS485)	Grey or yellow	65 DAT +
Data - (RS485)	Green or violet	66 DAT-
Cable shield	Connect to a large area of the frequency inverter housing or shielding bracket	

Table 27: Colour and contact assignments for Hiperface encoders

Information

Rotary encoder function test

The voltage difference between the SIN and COS tracks can be measured with the aid of parameters **P709 [-09]** and **[-10]**. When the Hiperface encoder is rotated, the voltage difference should range from approx. -0.5 V to 0.5 V.

2.10 RJ45 WAGO- Connection module

This adapter module can be used for the simple wiring of functions of the RJ45 connection (24V supply voltage, CANopen absolute encoder, CANbus) with normal cables.

Pre-assembled RJ45 patch cables are connected to the spring-loaded terminals (1-8 + S) with this adapter.

Contact	1	2	3	4	5	6	7	8	S
Meaning	CAN_H	CAN_L	CAN_GND	nc.	nc.	CAN_SHD	CAN_GND	CAN_24V	Shield

The shield clamp should be used in order to ensure the correct connection and relief of tension on the shield.

Supplier	Name	Article number
WAGO Kontakttechnik GmbH	Ethernet connection module with CAGE CLAMP connection RJ45 transfer module	289-175
WAGO Kontakttechnik GmbH	Accessories: WAGO shield clamp	790-108
Alternative, complete connection module and shield clamp		**Part No.**
Getriebebau NORD GmbH & Co.KG	Adapter module RJ45/terminal	278910300

Table 28: RJ45 WAGO connection module

3 Displays and control

As delivered, without the technology unit, 2 LEDs (green/red) are visible externally. These indicate the actual device status.

The **green LED** indicates that the mains voltage is present and operational, while a flashing code that increases in speed shows the degree of overload at the frequency inverter output.

The **red LED** signals actual error by flashing with a frequency which corresponds to the number code of the fault (see chapter 6 "Operating status messages").

3.1 Modular assemblies SK 5xxE

By the use of various modules for display, control and parameterisation, the SK 5xxE can be easily adapted to a wide range of requirements.

Alphanumerical display and operating modules can be used for simple commissioning. For more complex tasks, various connections to a PC or an automation system can be selected.

The **Technology Unit (Technology Unit, SK TU1-...)** is connected externally to the front of the frequency inverter and is therefore easy to access and replace at any time.

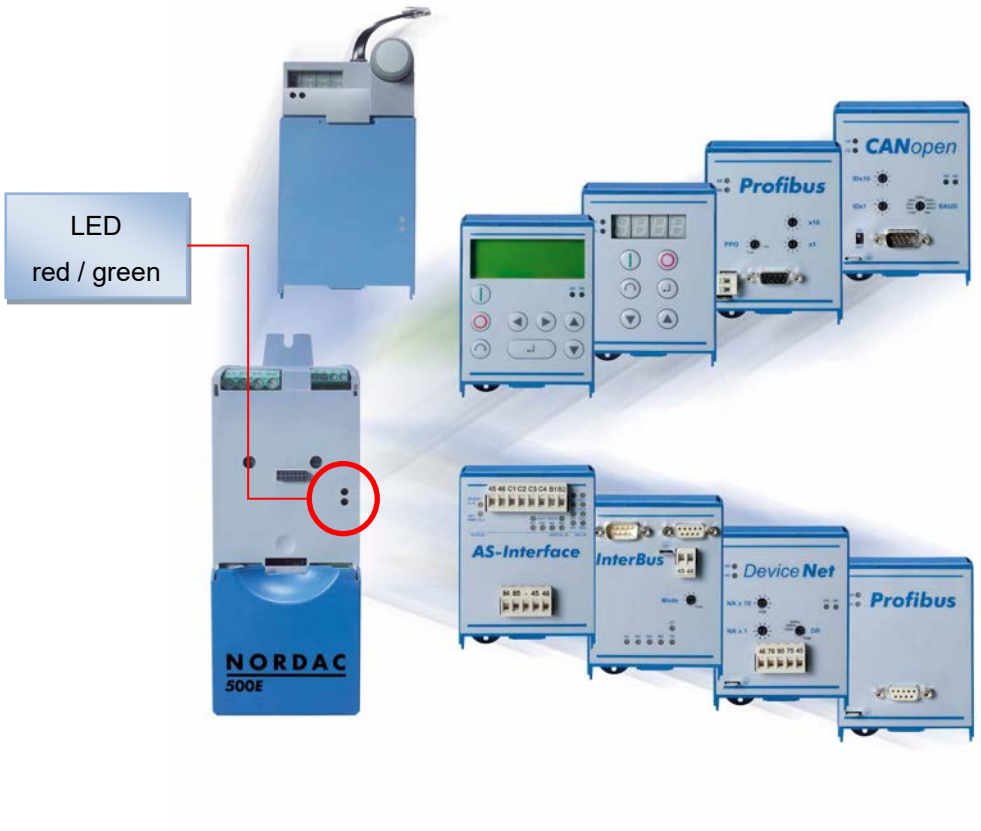


Fig. 8: Modular assemblies SK 5xxE

3.2 Technology units overview

Detailed information on the options can be found in the respective documents.

Control boxes

Module	Designation	Description	Data	Part no.	Document
SK CSX-0	SimpleBox	Commissioning, parameterisation and control of the frequency inverter	7-segment LED display, 4-digit, single-button operation	275900095	BU 0505 (chapter 3.3)
SK TU3-CTR	ControlBox	As for SK CSX-0 + saving the parameters of one inverter	7-segment LED display, 4-digit, keyboard	275900090	BU 0040
SK TU3-PAR	ParameterBox	As for SK CSX-0 + saving the parameters of up to 5 inverters	LCD display (illuminated), 4-line, keyboard	275900100	BU 0040
SK TU3-POT	PotentiometerBox	Direct control of the FI	ON, OFF, R/L, 0 … 100%	275900110	BU 0505 (chapter 3.4)

Interfaces

Module	Interface	Data	Part no.	Document
Conventional field bus protocols				
SK TU3-AS1	AS-Interface	4 sensors / 2 actuators 5-/ 8-pole screw terminals	275900170	BU 0090
SK TU3-CAO	CANopen	Baud rate: up to 1 Mbit/s Plug: Sub-D9	275900075	BU 2500 and TI 275900075
SK TU3-DEV	DeviceNet	Baud rate: 500 kbit/s 5-pole screw terminals	275900085	BU 2600 and TI 275900085
SK TU3-IBS	InterBus	Baud rate: 500 kbit/s (2 Mbit/s) Plug: 2x SUB-D9	275900065	BU 0070
SK TU3-PBR	Profibus DP	Baud rate: 1.5 Mbaud Plug: Sub-D9	275900030	BU 2700 and TI 275900030
SK TU3-PBR-24V	Profibus DP	Baud rate: 12 Mbaud Plug: Sub-D9 24 V DC connection via terminal	275900160	BU 2700 and TI 275900160
Ethernet-based BUS systems				
SK TU3-ECT	EtherCAT	Baud rate: 100 Mbaud Plug: 2x RJ45 24 V DC connection via terminal	275900180	BU 2300 and TI 275900180
SK TU3-EIP	EtherNet/IP	Baud rate: 100 Mbaud Plug: 2x RJ45 24 V DC connection via terminal	275900150	BU 2100 and TI 275900150
SK TU3-PNT	PROFINET IO	Baud rate: 100 Mbaud Plug: 2x RJ45 24 V DC connection via terminal	275900190	BU 2400 and TI 275900190
SK TU3-POL	POWERLINK	Baud rate: 100 Mbaud Plug: 2x RJ45 24 V DC connection via terminal	275900140	BU 2200 and TI 275900140

Information

USS and Modbus RTU

Optional modules are not required for communication via USS or Modbus RTU.

The protocols are integrated in all SK 5xxE devices. An interface is available via terminal X11 or, if available, also via X7:73/74.

A detailed description on both protocols can be found in manual BU 0050.

Other optional modules

Module	Interface	Data	Part no.	Document
SK EBGR-1	Electronic brake rectifier	Extension for direct control of an electromechanical brake, IP20, top-hat rail mounting	19140990	TI 19140990
SK EBIOE-2	IO extension	Extension with 4 DIN, 2 AIN, 2 DOUT and 1 AOUT, IP20, top-hat rail mounting, SK 54xE and higher	275900210	TI 275900210

Installation

Information

Installing the SK TU3-... technology unit

Modules should not be inserted or removed unless the device is free of voltage. The slots may only be used for the intended modules.

Installation of a technology unit **separate** from the frequency inverter is not possible. It must be connected directly to the frequency inverter.

The technology units must be **installed** as follows:

1. Switch off the mains voltage, observe the waiting period.
2. Push the control terminal cover down slightly or remove.
3. Remove the **dummy cover** by activating the release mechanism at the lower edge and removing it with an upwards rotating movement.
4. Hook the **technology unit** onto the upper edge and press in lightly until it engages.

   Take care that the plug connection bar is properly contacted and if necessary fix it with a suitable screw (self-tapping screw 2.9 mm x 9.5 mm, included in the scope of delivery of the frequency inverter).

5. Close the control terminal cover again.

3.3 SimpleBox, SK CSX-0

This option is used as a simple parameterisation and display tool for the SK 5xxE frequency inverter. If the BUS module is assigned, data can also be read out and parameters can be parameterised during active BUS operation.

Features

- 4-digit, 7-segment LED display
- Single-button operation of the frequency inverter
- Display of the active parameter set and operating value

After plugging in the SimpleBox, establishing the cable connection and switching on the mains voltage, horizontal lines are displayed on the 4-digit, 7-segment display. These indicate that the frequency inverter is ready for operation.

If a jog frequency is preset in parameter **P113** or a minimum frequency is preset in parameter **P104**, the display flashes with this value.

If the frequency inverter is enabled, the display automatically changes to the operating value set in parameter **P001** “Select of disp.value” (factory setting = actual frequency).

The currently used parameter set is indicated in binary code via the 2 LEDs below the display.

Figure 9: SimpleBox SK CSX-0

NOTICE

Parallel operation of control elements

As control elements in parallel operation use the same communication channel, communication errors may occur.

- Do not operate the SimpleBox SK CSX 0 in combination with SK TU3 POT, SK TU3 CTR, SK TU3 PAR, the handheld SK …-3H control units or their SK … 3E installation variants or the remote control window of the NORDCON software.

3.3.1 Installation

The SimpleBox can be plugged to every technology unit (SK TU3-...) or blank cover from above. To remove it, just pull it off after releasing the RJ12 connection (press the latching tab on the RJ12 plug).

3.3.2 Connection

The SimpleBox is connected to the socket on the frequency inverter’s upper edge using the RJ12 plug/cable (RS485 interface).

The BUS terminating resistor for the RS485 interface must be set via DIP switch 1 (left).

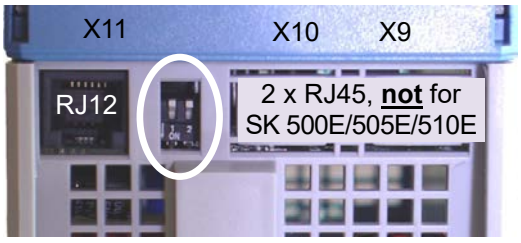


Figure 10: Top of the device with RJ12/RJ45 connection

3.3.3 SimpleBox functions

7-segment LED display	When the frequency inverter is ready for operation, a flashing display indicates a present initial value (**P104/P113** for keyboard operation). This frequency is approached immediately after enable. During operation, the currently set operating value (selection in **P001**) or an error code (Chapter 6) is displayed. During parameterisation, the parameter number or the parameter value is displayed.
LEDs  	The LEDs indicate the current operating parameter set in the operating display (**P000**) and the current parameter set to be parameterised during parameterisation. The display is in binary code. 
Knob, turn **right**	Turn the knob to the right to increase the parameter number or parameter value.
Knob, turn **left**	Turn the knob to the left to decrease the parameter number or parameter value.
Knob, press **shortly**	Press the knob shortly to use the “ENTER” function to save changed parameter values or to switch from the parameter number to parameter value.
Knob, press and **hold**	Press and hold the knob for the display to switch to the next higher level, if necessary without saving a parameter value change.

Table 29: SimpleBox SK CSX-0 functions

3.3.4 Control via SimpleBox

If **P549 = 1** is set and the operating value display **P000** is selected, the SimpleBox on the frequency inverter can be used to control the drive.

Press and hold the knob to start the drive; press the knob shortly to stop it again. The speed can be varied within the positive and negative range using the rotary knob.

Information

Stopping the drive

In this operating mode, the drive can only be stopped in the operating value display by using the knob (press shortly) or by switching the mains voltage off.

SimpleBox menu structure

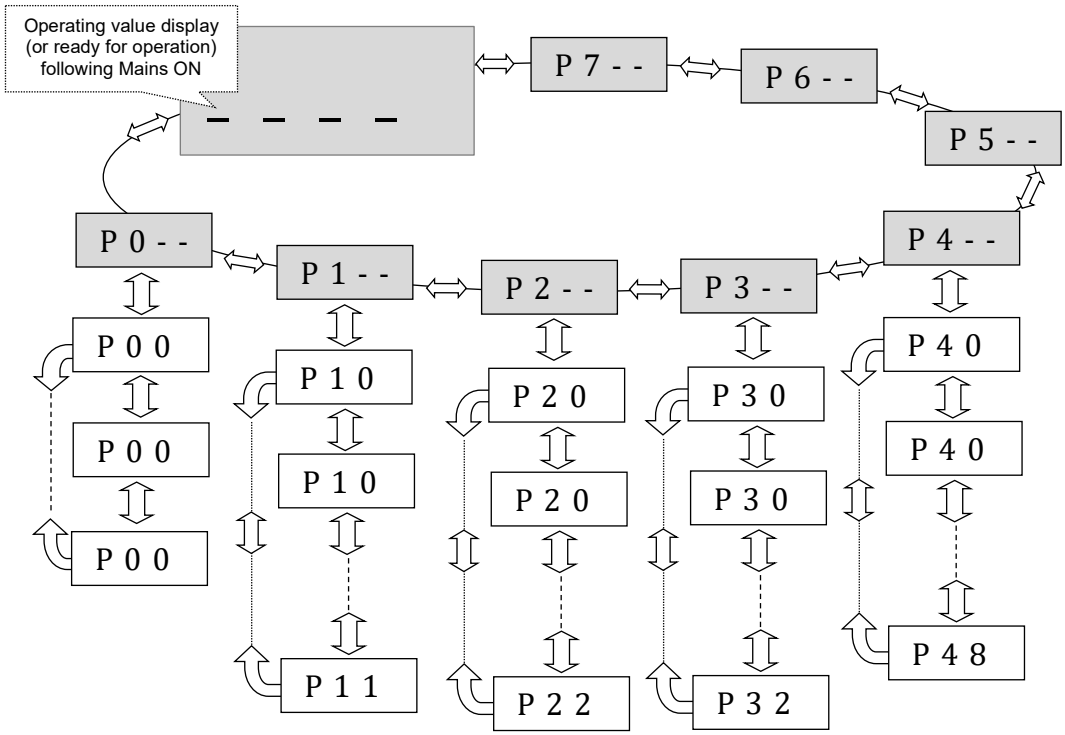
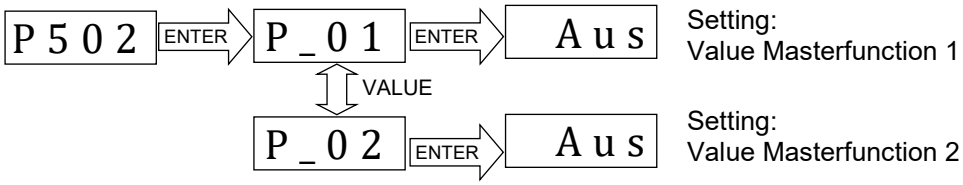


Figure 11: SimpleBox SK CSX-0 menu structure

NOTE: Some parameters such as P465, P475, P480 … P483, P502, P510, P534, P701 … P706, P707, P718, P740/741 and P748 have additional levels (arrays), which are used to make further settings, for example:



3.4 PotentiometerBox, SK TU3-POT

With the PotentiometerBox, the frequency inverter can be controlled directly on the device. This does not require any additional external components.

The buttons can be used to start, stop and change the direction of rotation. The direction of rotation is changed by pressing the *Start* or *Stop* buttons for 3 s.

The potentiometer is used to set the required frequency setpoint, which shall be approached after enable (green button).

The LEDs indicate the FI's state. If an inactive fault is present (red LED flashes), it can be acknowledged by pressing the STOP button.

Note: The PotentiometerBox must be activated by setting {1} "Set point frequency" in parameter P549 "Pot Box Function".

I/O buttons	**START/STOP** (green/red)	To enable and disable the output signal	
Potentiometer	**0 … 100%**	Sets the output frequency between f_{min} (P104) and f_{max} (P105)	
Red LED	Off		No fault
	Flashes		Inactive fault
	On		Active fault
Green LED	Off		FI switched off, enable with CW direction of rotation
	Flashing 1: briefly on, long off		FI switched off, enable with CCW direction of rotation
	Flashing 2: briefly on, briefly off		FI switched on with CCW direction of rotation
	On		FI switched on with CW direction of rotation

3.5 Connection of multiple device to a parameterisation tool

In principle it is possible to access several frequency inverters via the **ParameterBox** or the **NORD CON software**. In the following example, communication is made via the parameterisation tool, by tunnelling the protocols of the individual devices (max. 8) via the common system bus (CAN). The following points must be noted:

1. Physical bus structure

   Establish a CAN connection (system bus) between the devices (Terminal: X9 or X10 (Type: RJ 45))

2. Supply electricity (24 V) to the CAN bus. Establish the connection, for example via the RJ45 – WAGO connection module (see chapter 2.10 "RJ45 WAGO- Connection module")
3. Parameterisation

Parameter		**Settings on the inverter**							
No.	**Designation**	**FI 1**	**FI 2**	**FI 3**	**FI 4**	**FI 5**	**FI 6**	**FI 7**	**FI 8**
P503	Leading function output	4 (system bus active)							
P512	USS address	0	0	0	0	0	0	0	0
P513	Telegram time-out (s)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
P514	CAN bus baud rate	5 (250 kBaud)							
P515	CAN bus address	32	34	36	38	40	42	44	46

   To adopt the addresses, the 24 V supply of the CAN bus must be completely switched off for approx. 30 sec.

4. Connect the parameterisation tool as usual via RS485 (Terminal: X11 (Type: RJ12)) to the **first** frequency inverter.

Conditions / Restrictions:

a. In order to use the complete range of functions the **first** frequency inverter (*FI 1*) must at least correspond to the firmware status 2.2 R0 (SK 54xE) or 3.0 R0 (all other SK 5xxE devices).
b. All other connected frequency inverters from the series must at least have a firmware status of 2.1 R0, in order to display the devices 5 … 8 correctly. Devices with a firmware version which is older than 1.8 R0 do not have the required functionality.
c. If NORDCON is connected to an inverter other than *FI 1*, the status of *FI 1* will be displayed as "Not ready". The status of devices 5 – 8 will also be displayed as "Not ready" if they have a software status which is older than 2.1 R0.
d. The parameterisation tools must also correspond to the latest software status:

NORDCON	≥ 02.03.00.21
ParameterBox	≥ 4.5 R3.

4 Commissioning

When the voltage supply is applied to the frequency inverter, it is ready for operation shortly afterwards. In this state, the frequency inverter can be adapted to the requirements of the application, i.e. parameterised (see chapter 5 "Parameter").

Only after the parameters have been set to the application by qualified personnel, the connected motor may be started.

DANGER!

Danger of electric shock

The frequency inverter continues to carry hazardous voltages for up to 5 minutes after it was switched off.

- Work must not be carried out unless the device has been disconnected from the voltage and at least 5 minutes have elapsed since the mains was switched off!

4.1 Factory settings

All frequency inverters supplied by Getriebebau NORD are pre-parameterised with the default setting for standard applications with 4-pole IE1 three-phase standard motors (same power and voltage). When using motors with a different power or number of poles, the data from the motor's name plate must be entered into the parameters **P201 ... P207** under the menu item >Motor data<.

Information

Pre-setting data via parameter P200

All data from IE1 / IE4 and IE5+ motors can be pre-set with parameter **P200**. After the function has been used, this parameter is reset to *0 = No change*! The data is automatically loaded once into parameters **P201 ... P209** and can be compared with the data on the motor name plate.

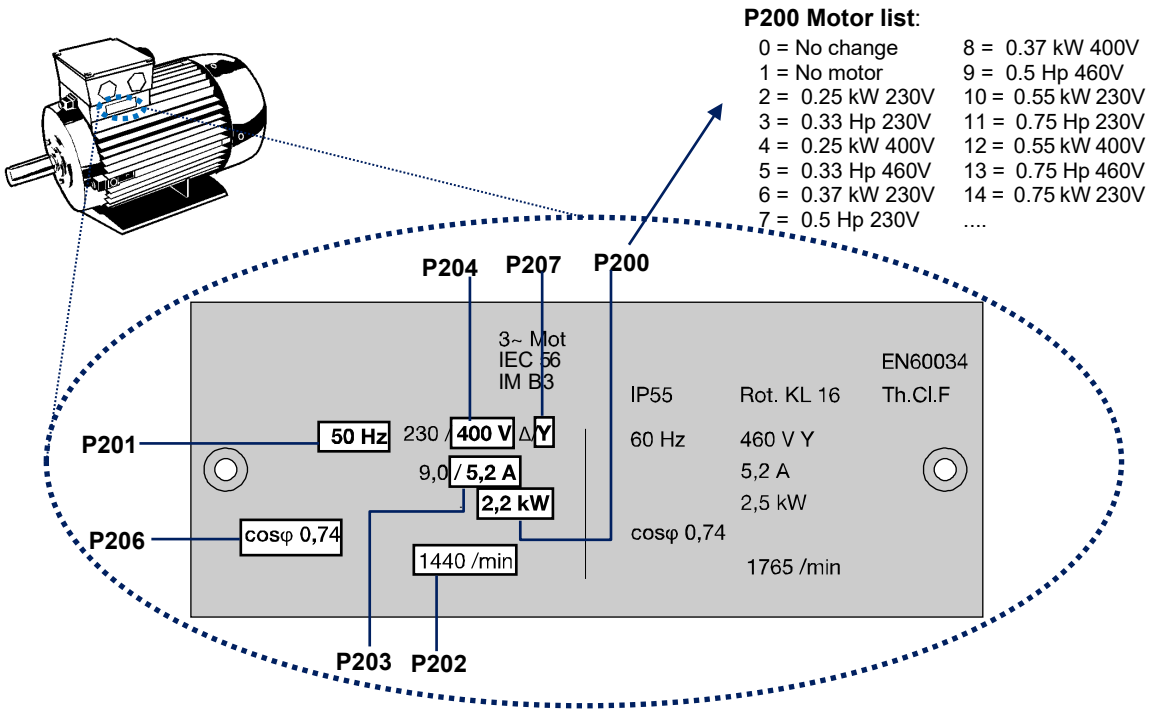


Figure 12: Motor name plate

RECOMMENDATION: For correct operation of the drive unit, it is necessary to set the motor data as accurately as possible in accordance with the name plate. In particular, automatic stator resistance measurement using parameter **P220** is recommended.

To automatically determine the stator resistance, **P220 = 1** must be set and confirmed by pressing “ENTER”. The value calculated for the line resistance (depending on **P207**) will be saved in parameter **P208**.

Motor data for IE2/IE3 motors are provided via the NORDCON software. With the aid of the "Import motor parameter" function (also refer to the NORDCON software manual BU 0000), the required data set can be selected and imported into the frequency inverter.

4.2 Selecting the operating mode for motor control

The frequency inverter is able to control motors with efficiency classes IE1 to IE5+. Our motors are designed as asynchronous motors in efficiency classes IE1 to IE3, and IE4 and IE5+ motors are designed as synchronous motors.

In terms of control technology, the operation of synchronous motors shows many special features. In order to achieve ideal results, the frequency inverter was therefore designed for the control of synchronous motors from NORD, which match the type of an IPMSM (Interior Permanent Magnet Synchronous Motor) in terms of structure. In these motors, the permanent magnets are embedded in the rotor. The operation of other manufacturer's motors must be checked by NORD, if required. See also technical information TI 60-0001, “Planning and commissioning guide for NORD synchronous motors (PMSM) with NORD frequency inverters”.

4.2.1 Explanation of the operating modes (P300)

The frequency inverter provides different operating modes for the control of a motor. All operating modes can be used with either an ASM (asynchronous motor) or a PMSM (Permanent Magnet Synchronous Motor), however various constraints must be complied with. In principle, all these methods are "flux oriented control methods.

VFC open-loop mode (P300, setting “0”)
This operating mode is based on a voltage-controlled, field-oriented control method (Voltage Flux Control Mode “VFC”). It is used with ASM and PMSM. In the context of the operation of asynchronous motors, the term “ISD control” is also used.
Control takes place without encoder and only based on fixed parameters and measurement results of actual electrical values. No specific settings of the speed control is required to use this operating mode. However, the parametrisation of motor data as precisely as possible is an essential condition for high-quality operation.
For the ASM mode, there is also the possibility of control according to a simple V/f characteristic curve. This mode is suitable for the operation of several, mechanical, non-coupled motors in parallel on a frequency inverter, or if the motor data cannot be precisely determined.
Operation according to a V/f characteristic curve is only suitable for drive applications with low requirements on the quality of speed control and dynamics (ramp times ≥ 1 s). Even for machinery that, due to its design, tends towards mechanical vibrations, control according to a V/f characteristic curve may be advantageous. V/f characteristic curves are usually used to control fans, certain pump drives or for agitators. Operation according to V/f characteristic curve is activated via the parameters (**P211**) and (**P212**) (setting “0” each).

- CFC closed-loop – Mode (P300, setting “1”)

  In comparison with setting “0” “VFC open-loop – Mode”, this is generally a control with current-controlled field orientation (Current Flux Control). For this operating mode, which with ASM is

functionally identical to the designation previously listed under “servo control”, the use of an encoder is mandatory. This way, the motor’s exact speed characteristics are recorded and included in the calculation for the motor control. The determination of the rotor position is enabled by the encoder, where for the operation of a PMSM the initial value of the rotor position must be determined. This allows for a more precise and faster control of the drive.
For ASM and PMSM, this operating mode provides the optimal results in control behaviour, and is especially suitable for lifting gear applications or applications with requirements on optimal dynamic behaviour (ramp times ≥ 0.05 s). This operating mode has the greatest benefit in connection with a motor of energy efficiency class IE5+ (energy efficiency, dynamics, precision).

- CFC open-loop mode (P300, setting “2”)
  The CFC mode is also possible in the open-loop method, i.e. in operation without encoder. Speed and position detection are determined using “observers” from measuring and actuating values. The prerequisite for this operating mode is a precise setting of the current and speed control. This operating mode is suitable for applications with higher requirements on dynamics (ramp times ≥ 0.25 s) compared to the VFC control, and also for pumping applications with high starting torques.

4.2.2 Overview of control parameter settings

The following provides an overview of all parameters which are of importance, depending on the selected operating mode. Among other things, a distinction is made between "relevant" and "important", which provides an indication of the required precision of the particular parameter setting. However, in principle, the more precisely the setting is made, the more exact the control, so that higher values for dynamics and precision are possible for the operation of the drive unit. A detailed description of these parameters can be found in Section 5 "Parameter".

"Ø" =	Parameter has no significance	"-" =	Leave the parameter in the factory setting
"√" =	Setting of the parameter is relevant	"!" =	Setting of the parameter is important

Group	Parameter	Operating mode					
		VFC open-loop		CFC open-loop		CFC closed-loop	
		ASMs	PMSMs	ASMs	PMSMs	ASMs	PMSMs
Motor data	P201 … P209	√	√	√	√	√	√
	P208	!	!	!	!	!	!
	P210	√ [1)]	√	√	√	Ø	Ø
	P211, P212	- [2)]	-	-	-	-	-
	P215, P216	- [1)]	-	-	-	-	-
	P217	√	√	√	√	Ø	Ø
	P220	√	√	√	√	√	√
	P240	-	√	-	√	-	√
	P241	-	√	-	√	-	√
	P243	-	√	-	√	-	√
	P244	-	√	-	√	-	√
	P246	-	√	-	√	-	√
	P245, 247	-	√	Ø	Ø	Ø	Ø
Controller data	P300	√	√	√	√	√	√
	P301	Ø	Ø	Ø	Ø	!	!
	P310 … P320	Ø	Ø	√	√	√	√
	P312, P313, P315, P316	Ø	Ø	-	√	-	√
	P330 … P333	-	√	-	√	-	√
	P334	Ø	Ø	Ø	Ø	-	√

[1)] = For V/f characteristic curve: precise matching of the parameter is important.

[2)] = For V/f characteristic curves: typical setting "0"

4.2.3 Motor control commissioning steps

The main commissioning steps are mentioned below in their ideal order. The correct assignment of the frequency inverter/motor and the mains voltage selection are assumed. Detailed information, especially for optimisation of the current, speed and position controllers of asynchronous motors is described in the guide “Controller Optimisation” (AG 0100). Detailed information on commissioning and optimisation for PMSMs in CFC closed-loop mode can be found in the “Drive Optimisation” guide (AG 0101). Please contact our Technical Support.

1. Carry out the frequency inverter and motor connection as usual (note Δ / Y!). Connect the encoder, if present.
2. Connect the mains supply.
3. Carry out the factory setting (P523).
4. Select the basic motor from the motor list (P200) (ASM types are at the beginning of the list, PMSM types are at the end, designated by their type (e.g. **…80T…**)).
5. Check the motor data (P201 … P209) and compare with the name plate/motor data sheet.
6. Measure the stator resistance (P220) → P208, P241[-01] are measured, P241[-02] is calculated. (Note: If an SPMSM is used, P241[-02] must be overwritten with the value from P241[-01]). Leave the existing values for parameters P241[-03] to P241[-06].)
7. Encoders: Check the settings (P301, P735)
8. With PMSM only:
   a. EMF voltage (P240) → Motor name plate/motor data sheet
   b. Determine/set reluctance angle (P243) (not required with NORD motors)
   c. Peak current (P244) → Motor data sheet (not required with NORD motors)
   d. Only for PMSMs in VFC mode:
      Determine (P245), (P247)
   e. Determine (P246)
9. Select the operating mode (P300).
10. Determine/set the current controller (P312 … P316).
11. Determine/set the speed controller (P310, P311).
12. PMSM only:
    a. Select the procedure for the recognition of the rotor position (P330).
    b. Make the settings for the starting behaviour (P331 … P333).
    c. Make the settings for the 0 pulse of the encoder (P334 … P335)
    d. Activation of slip error monitoring (P327 ≠ 0 and P328 ≠ 0)

Information

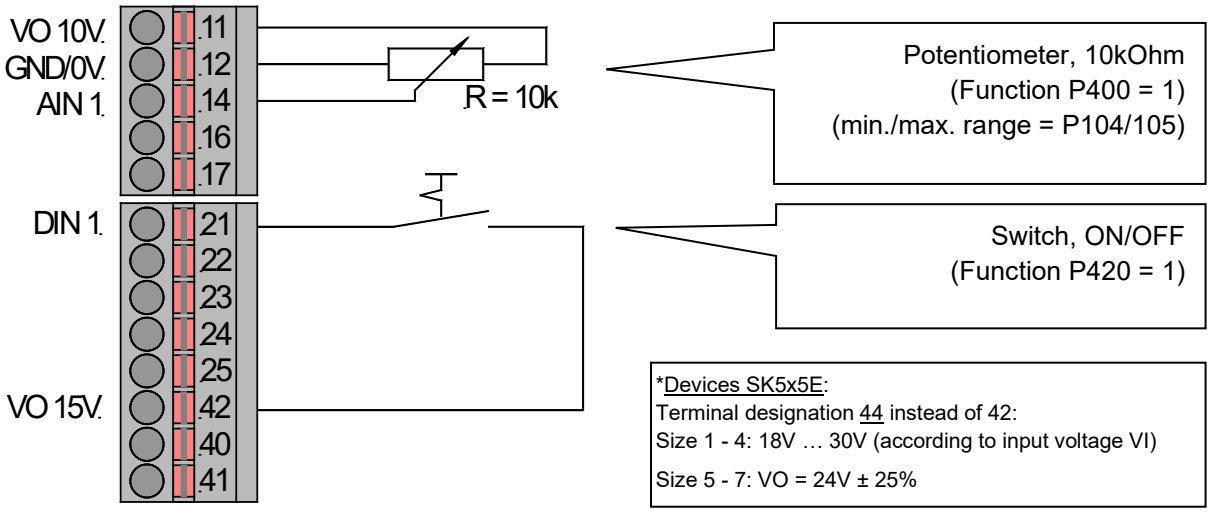
Commissioning of NORD synchronous motors

Further information on the commissioning of NORD synchronous motors with NORD frequency inverters can be found in the AG 0101 application guide.

4.3 Minimal configuration of control connections

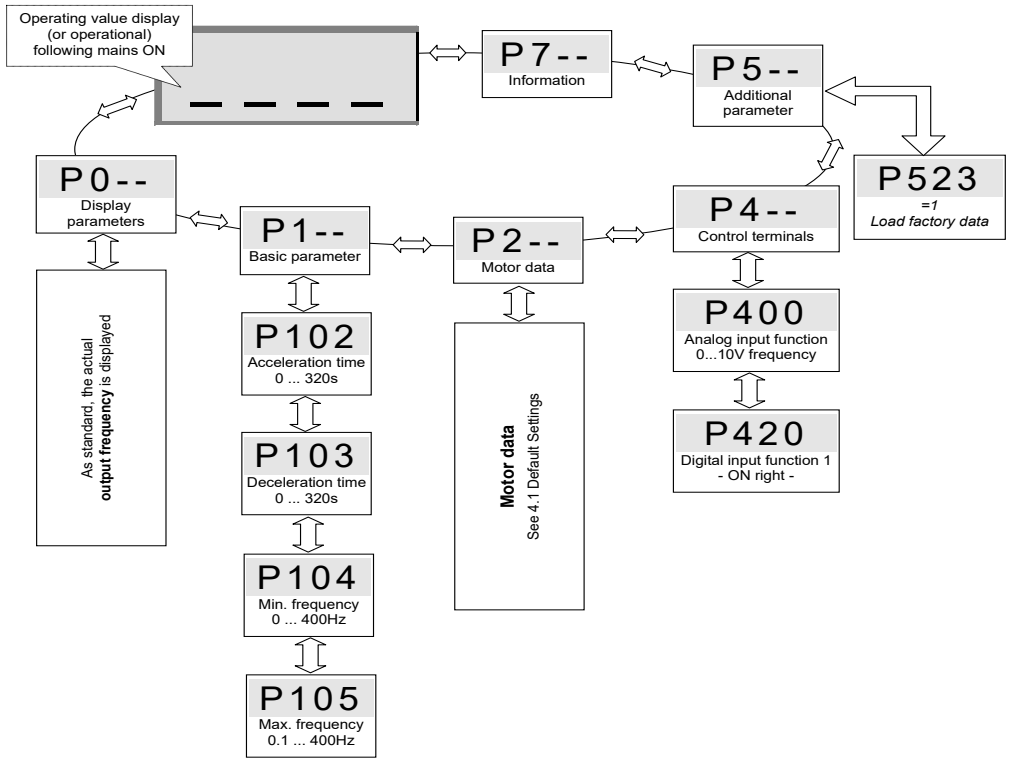
If the frequency inverter is to be controlled via the digital and analog inputs, this can be implemented immediately in the condition as delivered. Settings are not necessary for the moment.

Minimum connections



Basic parameters

If the current setting of the frequency inverter is not known, loading the default setting is recommended → P523 = 1. The inverter is pre-programmed for standard applications in this configuration. If necessary, the following parameters can be adjusted with the optional SimpleBox SK CSX-0 or ControlBox TU3-CTR.



4.4 Temperature sensors

The current vector control of the frequency inverter can be further optimised by the use of a *temperature sensor*. By continuous measurement of the motor temperature, the highest control precision of the frequency inverter and the associated optimum speed precision of the motor is achieved at all times and with any load. As the temperature measurement starts immediately after (mains) switch-on of the frequency inverter, the frequency inverter provides immediate optimum control, even if the motor has a considerably increased temperature after an intermediate “Mains off/Mains on” of the frequency inverter.

Information

Determination of motor stator resistance

To determine the stator resistance of the motor, the temperature range 15 … 25 °C should not be exceeded in either direction.

The motor overtemperature is also monitored and at 155 °C (switching threshold as with the PTC resistor) causes the drive to switch off with error message E002.

Information

Pay attention to polarity

Temperature sensors are wired semiconductors that must be operated in the conducting direction. For this, the anode must be connected to the "+" contact of the analogue input. The cathode must be connected to earth.

Failure to observe this can lead to false measurements. Motor winding protection is therefore no longer guaranteed.

Approved temperature sensors

The function of the approved temperature sensors is comparable. However, their characteristic curves differ. Correct matching of the characteristic curves to the frequency inverter is made by changing the following two parameters.

Sensor type	Shunt resistor [kΩ]	P402[xx][1] 0% adjustment [V]	P403[xx][1] 100% adjustment [V]
KTY84-130	2.7	1.54	2.64
1)	xx = parameter array, depending on the analogue input used		

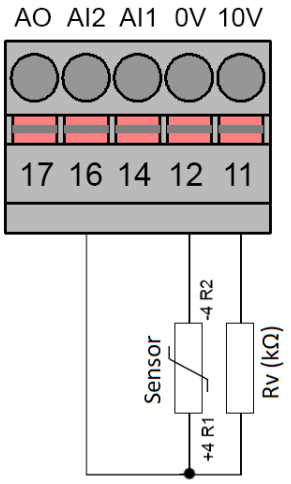
Table 30: Temperature sensors, adjustment

Connection of a temperature sensor is made according to the following examples.

Taking into account the relevant values for the 0% adjustment [P402] and 100% adjustment [P403], these examples can be used for all of the approved temperature sensors which are stated above.

Connection examples

A temperature sensor can be connected to either of the two analogue inputs of the relevant option. In the following examples, analogue input 2 is used.



Parameter settings (Analogue input 2)

The following parameters must be set for the function of the temperature sensor.

1. Analogue input 2 function, **P400 [-02] = 48** (motor temperature)
2. Analogue input 2 mode, **P401 [-02] = 1** (negative temperatures are also measured)
3. Comparison of analogue input 2: **P402 [-02]** (V) and **P403 [-02]** (V) for R_V (kΩ)
4. Motor temperature monitoring (display): **P739 [-03]**

4.5 Frequency addition and subtraction via operating boxes

(software version 1.7 and above)

If the parameter P549 (PotentiometerBox Function) is set to 4 “Frequency addition” or 5 “Frequency subtraction”, a value can be added or subtracted via the **value keys** ▲ or ▼ with the ControlBox or the ParameterBox.

If the ENTER key ↵ is confirmed, the value is saved in P113. The next time the device is started, the value will be added or subtracted immediately.

As soon as the inverter is enabled, the ControlBox switches to the operating display. With the ParameterBox, a change of value can only be made in the operating display. If the ControlBox is enabled, parameterisation is no longer possible. Enabling via the ControlBox or ParameterBox is also no longer possible in this mode, even if P509 = 0 and P510 = 0.

Note: In order to safely activate the ParameterBox in this mode, the STOP key ⭘ must be pressed once.

5 Parameter

⚠ WARNING

Unexpected movement

Connection of the supply voltage may directly or indirectly set the drive unit into motion. This can cause unexpected movement of the drive and the attached machine, which may result in serious or fatal injuries and/or material damage. Possible causes of unexpected movements are e.g.:

- Parameterisation of an "automatic start"
- Incorrect parameterisation
- Control of the device with an enabling signal from a higher level control unit (via IO or bus signals)
- Incorrect motor data
- Incorrect encoder connection
- Release of a mechanical holding brake
- External influences such as gravity or other kinetic energy which acts on the drive unit
- In IT networks: Earth fault (short circuit to earth)

- To avoid any resulting hazard the drive or drive chain must be secured against unexpected movements (mechanical blocking and/or decoupling, provision of protection against falling, etc.) In addition, it must be ensured that there are no persons within the area of action and the danger area of the system.

⚠ WARNING

Unexpected movement due to changes in the parameterisation

Parameter changes become effective immediately. Under certain conditions, dangerous situations may occur, even when the drive is in standstill. Functions such as **P428** “Automatic starting” or **P420** “Digit inputs” or the “Brake off” setting can put the drive in motion and put persons at risk due to moving parts.

Therefore:

- Changes to parameter settings must only be made when the Frequency Inverter is not enabled.
- During parametrisation works, precautions must be taken to prevent unwanted drive movements (e.g. lifting equipment plunging down). The danger area of the system must not be entered.

⚠ WARNING

Unexpected movement due to overload

In case of overload of the drive there is a risk that the motor will "break down" (sudden loss of torque). An overload may be caused e.g. by inadequate dimensioning of the drive unit or by the occurrence of sudden peak loads. Sudden peak loads may be of a mechanical origin (e.g. blockage) or may be caused by extremely steep acceleration ramps (P102, P103, P426).

Depending on the type of application, "breakdown" of the motor may cause unexpected movement (e.g. dropping of loads by lifting equipment).

To prevent any risk, the following must be observed:

- For lifting equipment applications or applications with frequent large load changes, parameter P219 must remain in the factory setting (100 %).
- Do not inadequately dimension the drive unit, provide adequate overload reserves.
- If necessary, provide fall protection (e.g. for lifting equipment) or equivalent protective measures.

Each frequency inverter is factory-set to a motor of the same power. All parameters can be adjusted “online”. Four parameter sets are available, which are switchable during operation. When delivered, all parameters are visible, but can partly be hidden with parameter P003.

NOTICE

Invalid data

As there are dependencies between the parameters, invalid internal data may occur for a short time, resulting in faults during operation.

- During operation, only edit the inactive parameter sets or non-critical settings.

The individual parameters are combined into different groups. The first digit of the parameter number indicates the assignment to a **menu group**:

Menu group	No.	Master function
Operating displays	(P0--)	Used to select the physical unit of the display value
Basic parameters	(P1--)	Contain basic frequency inverter settings, for example switch-on and switch-off behaviour, and together with the motor data, are sufficient for standard applications
Motor data	(P2--)	Used to set motor-specific data; important for ISD current control and selection of the characteristic curve by setting dynamic and static boost
Control parameters (SK 520E and higher)	(P3--)	Used to set the controller parameters (current controller, speed controller, etc.) for speed feedback
Control terminals	(P4--)	Used to scale the analogue inputs and outputs and to determine the functions of digital inputs and relay outputs as well as PID control parameters
Additional parameters	(P5--)	Functions concerning the interface, pulse frequency or fault acknowledgement, for example.
Positioning (SK 53xE or higher)	(P6--)	Used to set the positioning function. Details can be found in BU 0510.
Information	(P7--)	Display current operating values, old error messages, device state messages or the software version
Array parameters	-01 … -xx	Some parameters can also be programmed or read out in several levels (arrays). After selecting the parameter, the array level must be selected as well.

Information

Factory setting P523

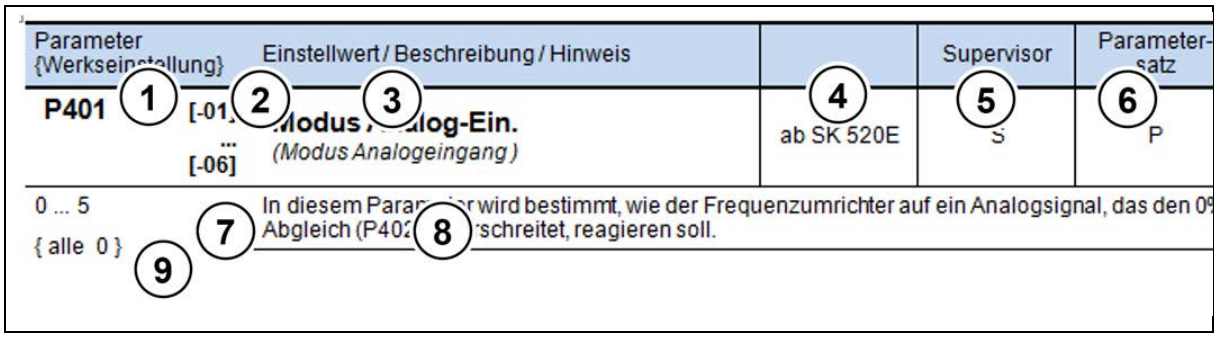
The factory settings of the entire parameter set can be loaded at any time using parameter **P523**. For example, this can be useful during commissioning if it is not known which device parameters have been previously changed and could have an unexpected influence on the operating behaviour of the drive.

The restoration of the factory settings (**P523**) normally affects all parameters. This means that all motor data must subsequently be checked or reconfigured. However, parameter **P523** also provides a facility for excluding the motor data or the parameters relating to bus communication when the factory settings are restored.

It is advisable to back up the present settings of the frequency inverter beforehand.

Availability of parameters

Due to certain configurations, the parameters are subject to certain conditions. The following tables list all parameters together with the particular information.

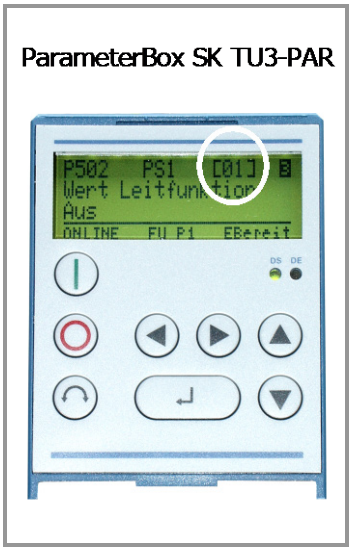


1	Parameter number
2	Array values
3	Parameter text; Top: P-Box display, bottom: Meaning
4	Special features (e.g.: only available for SK 520E and above)
5	Supervisor parameters (S) are dependent on the settings in P003
6	Parameter set dependent (P) parameter selections in P100
7	Parameter value range
8	Description of the parameter
9	Default values (factory settings) of the parameter

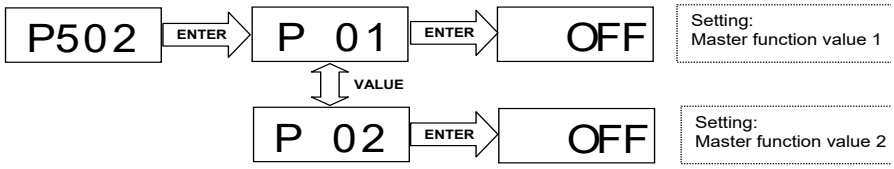
Array parameter display

Some parameters have the option of displaying settings and views in several levels (arrays). After the parameter is selected, the array level is displayed and must then also be selected.

If the ControlBox is used, the array level is shown by [_ - 0 1]. With the ParameterBox (picture on right) the selection options for the array level appear at the top left of the display.



For parameterisation with ControlBox SK TU3-CTR:



5.1.1 Operating displays

Abbreviations used:

- **FI** = Frequency inverter
- **SW** = Software version, stored in P707.
- **S = Supervisor parameters** are visible or hidden depending on P003.

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set
P000	**Operating display** *(Operating parameter display)*			
0.01 ... 9999	In ParameterBoxes with 7-segment displays (e.g. SimpleBox) the operating value which is selected in P001 is displayed *online*. Important information about the operating status of the drive can be read out as required.			
P001	**Display selection** *(Display selection)*			
0 ... 65 { 0 }	Selection of operating display of a parametrisation box with 7-segment display (e.g.: SimpleBox)			

0 =	**Actual frequency [Hz]**	Currently supplied output frequency
1 =	**Speed [rpm]**	Calculated speed
2 =	**Target frequency [Hz]**	Output frequency that corresponds to the pending setpoint. This need not correspond with the current output frequency.
3 =	**Current [A]**	Current measured output current
4 =	**Actual torque current [A]:**	Torque-forming output current
5 =	**Voltage [V AC]**	Current alternating voltage present at the device output
6 =	**Link voltage [V DC]**	The *Link voltage [Vdc]* is the FI-internal DC voltage. Amongst other things, this depends on the level of the mains voltage.
7 =	**cos Phi**	Current calculated value of the power factor
8 =	**Apparent power [kVA]**	Calculated current apparent power
9 =	**Effective power [kW]**	Calculated current effective power
10 =	**Torque [%]**	Calculated current torque
11 =	**Field [%]**	Calculated current field in motor
12 =	**Hours of operation [h]**	Time for which main voltage present at device
13 =	**Operating time Enable [h]**	*"Enabled operating hours"* is the time for which the device was enabled.
14 =	**Analogue input 1 [%]**	Current value that is present at analogue input 1 of the device
15 =	**Analogue input 2 [%]**	Current value that is present at analogue input 2 of the device
16 =	**… 18**	*Reserved*, POSICON
19 =	**Heat sink temperature [°C]**	Current temperature of the heat sink
20 =	**Actual utilisation of motor [%]**	Average motor utilisation, based on the known motor data (P201...P209).
21 =	**Brake resistor utilisation [%]**	*"Braking resistor utilisation"* is the average braking resistor load, based on the known resistance data (P556...P557).
22 =	**Interior temperature [°C]**	Current interior temperature of device *(SK 54xE / SK 2xxE)*
23 =	**Motor temperature**	Measured via KTY-84
24 =	**… 29**	*Reserved*
30 =	**Present Target MP-S [Hz]**	*"Current motor potentiometer function setpoint with storage"*. (P420…=71/72). The nominal value can be read out with this function or pre-set (without the drive running).
31 =	**… 39**	*Reserved*
40 =	**PLC control box value**	Visualisation mode for PLC communication
41 =	**… 59**	*Reserved*, POSICON
60 =	**R stator ident**	Stator resistance determined by means of measurement (P220)
61 =	**R rotor ident**	the rotor resistance determined by measurement ((P220) Function 2)
62 =	**L stray stator ident**	the stray inductance determined by measurement ((P220) Function 2)
63 =	**L stator ident**	the inductance determined by measurement ((P220) Function 2)
65 =		*Reserved*

P002	Display factor *(Display factor)*		S	
0.01 ... 999.99 { 1.00 }	The selected operating value in parameter P001 >Select of display< is multiplied with the scaling factor in P000 and displayed in >Operating parameter display<. It is therefore possible to display system-specific operating such as e.g. the throughput quantity			

P003	Supervisor-Code *(Supervisor code)*			
0 ... 9999 { 1 }	**0 = The supervisor** parameters are **not** visible. **1 = All parameters** are visible. **2 = Only menu group 0** >Operating para. disp< (P000 and P003) is visible. **3** ... 9999, as with setting value 2.			
0 ... 9999 { 1 }	**0 = The supervisor parameters** are **not** visible. **1 = All parameters** are visible. **2 = Only menu group 0** >Operating para. disp< (P000 and P003) is visible. 3 ... 9999, as with setting value 2.			

Information

Display via NORDCON

If parameterisation is carried out with the NORDCON software, the settings 2 … 9999 are like the 0 setting.

5.1.2 Basic parameters

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set

P100	Parameter set *(Parameter set)*		S	
0 ... 3 { 0 }	Selection of the parameters sets to be parameterised. 4 parameter sets are available. The parameters to which different values can also be assigned in the 4 parameter sets are known as "parameter set-dependent" and are marked with a **"P"** in the header in the following descriptions. The operating parameter set is selected using appropriately parametrised digital inputs or by means of BUS actuation. If enabled via the keyboard (SimpleBox, ControlBox, PotentiometerBox or ParameterBox), the operating parameter set will match the settings in P100.			

P101	Copy parameter set *(Copy parameter set)*		S	
0 ... 4 { 0 }	After confirmation with the OK / ENTER key, a copy of the parameter set selected in P100 >Parameter set< is written to the parameter set dependent on the value selected here **0 = Do not copy** **1 = Copy actual to P1**: Copies the active parameter set to parameter set 1 **2 = Copy actual to P2**: Copies the active parameter set to parameter set 2 **3 = Copy actual to P3**: Copies the active parameter set to parameter set 3 **4 = Copy actual to P4**: Copies the active parameter set to parameter set 4			

P102	**Acceleration time** *(Acceleration time)*			P
0 ... 320.00 sec { 2.00 } { 5.00 } ≥ 45 kW	The start-up time is the time corresponding to the linear frequency rise from 0 Hz to the set maximum frequency (P105). If an actual setpoint of <100 % is being used, the acceleration time is reduced linearly according to the setpoint which is set. The acceleration time can be extended by certain circumstances, e.g. FI overload, setpoint lag, smoothing, or if the current limit is reached. **NOTE:** Care must be taken that the parameter values are realistic. A setting of P102 = 0 is not permissible for drive units! **Notes on ramp gradient:** Amongst other things, the ramp gradient is governed by the inertia of the rotor. A ramp with a gradient which is too steep may result in the "inversion" of the motor. In general, extremely steep ramps (e.g.: 0 - 50 Hz in < 0.1 s) should be avoided, as may cause damage to the frequency inverter.			

P103	**Braking time** *(Braking time)*			P
0 ... 320.00 sec { 2.00 } { 5.00 } ≥ 45 kW	The braking time is the time corresponding to the linear frequency reduction from the set maximum frequency to 0 Hz (P105). If an actual setpoint <100 % is being used, the deceleration time reduces accordingly. The braking time can be extended by certain circumstances, e.g. by the selected >Switch-off mode< (P108) or >Ramp smoothing< (P106). **NOTE:** Care must be taken that the parameter values are realistic. A setting of P103 = 0 is not permissible for drive units! **Notes concerning ramp steepness:** see parameter (P102)			

P104	**Minimum frequency** *(Minimum frequency)*			P
0.0 ... 400.0 Hz { 0.0 }	The minimum frequency is the frequency supplied by the FI as soon as it is enabled and no additional setpoint is set. In combination with other setpoints (e.g. analog setpoint of fixed frequencies) these are added to the set minimum frequency. This frequency is undershot when a. the drive is accelerated from standstill. b. The FI is blocked. The frequency then reduces to the absolute minimum (P505) before it is blocked. c. The FI reverses. The reverse in the rotation field takes place at the absolute minimum frequency (P505). This frequency can be continuously undershot if, during acceleration or braking, the function "Maintain frequency" (Function Digital input = 9) is executed.			

P105	Maximum frequency *(Maximum frequency)*			P

0.1 ... 400.0 Hz
{ 50.0 }

The frequency supplied by the FI after being enabled and once the maximum setpoint is present, e.g. analogue setpoint as per P403, a correspondingly fixed frequency or maximum via the ControlBox.

This frequency can only be overshot by the slip compensation (P212), the function "Maintain frequency" (function digital input = 9) or a change to another parameter set with lower maximum frequency.

Maximum frequencies are subject to certain restrictions, e.g.

- Restrictions in weak field operation,
- Compliance with mechanically permissible speeds,
- PMSM: Restriction of the maximum frequency to a value which is slightly above the rated frequency. This value is calculated from the motor data and the input voltage.

P106	Ramp smoothing *(Ramp smoothing)*			P

0 ... 100 %
{ 0 }

This parameter enables a smoothing of the acceleration and deceleration ramps. This is necessary for applications where gentle, but dynamic speed change is important.

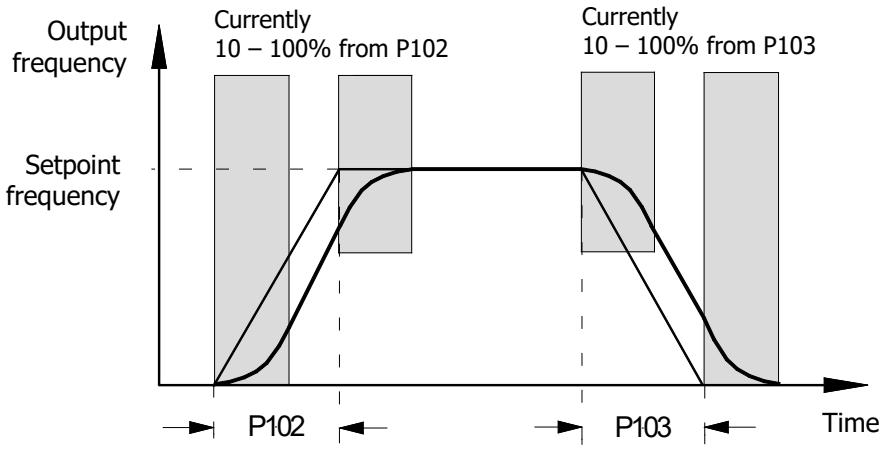
Ramp smoothing is carried out for every setpoint change.

The value to be set is based on the set acceleration and deceleration time, however values <10% have no effect.

The following then applies for the entire acceleration or deceleration time, including rounding:

$$t_{tot\ \mathrm{ACCELERATION\,TIME}} = t_{P102} + t_{P102} \cdot \frac{P106\,[\%]}{100\%}$$

$$t_{tot\ \mathrm{DECELERATION\,TIME}} = t_{P103} + t_{P103} \cdot \frac{P106\,[\%]}{100\%}$$



P107	**Brake reaction time** *(Brake reaction time)*			P

0 ... 2.50 s
{ 0.00 }

Electromagnetic brakes have a physically-dependent delayed reaction time when actuated. This can cause a dropping of the load for lifting applications, as the brake only takes over the load after a delay.

The reaction time must be taken into consideration by setting parameter P107.

Within the adjustable application time, the FI supplies the set absolute minimum frequency (P505) and so prevents movement against the brake and load drop when stopping.

If a time > 0 is set in P107 or P114, at the moment the FI is switched on, the level of the excitation current (field current) is checked. If no magnetising current is present, the FI remains in magnetising mode and the motor brake is not released.

In order to achieve a shut-down and an error message (E016) in this case, P539 must be set to 2 or 3.

See also the parameter >Release time< P114

Information

Brake control

To control the electromechanical brake (especially for lifting gears), an internal relay should be used (function 1, external brake **P434/441**). The absolute minimum frequency (**P505**) should never be less than 2.0 Hz.

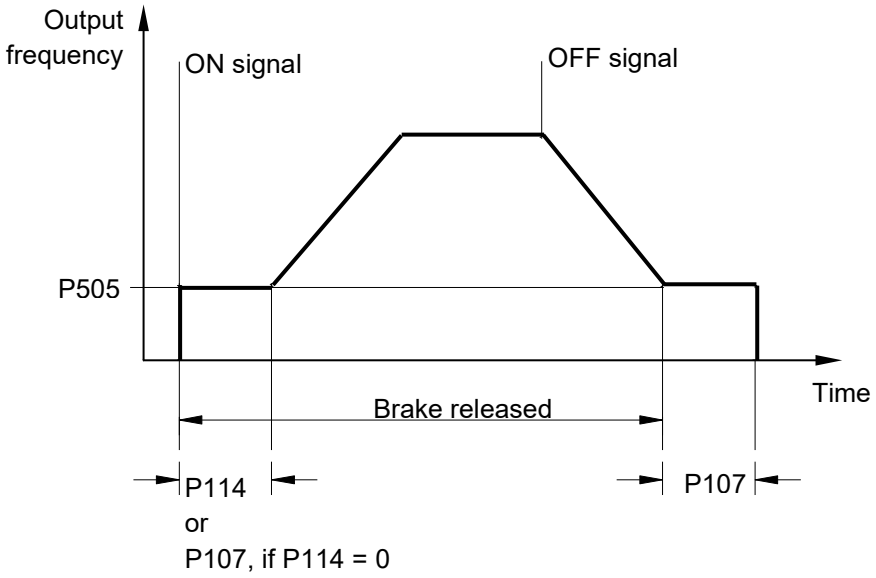
Recommended parameterisation for the application:
Lifting gear with brake without speed feedback

P114 = 0.02 ... 0.4 s *
P107 = 0.02 ... 0.4 s *
P201 … **P208** = Motor data
P434 = 1 (ext. brake)
P505 = 2 ... 4 Hz

For safe starting
P112 = “Off”
P536 = “Off”
P537 = Factory setting
P539 = Check of exciting current

Against load drops
P214 = 50 ... 100% (precontrol)

* Setting values (**P107**/**P114**) depend on braking type and motor size. For low powers (< 1.5 kW), smaller values apply; for higher powers (> 4.0 kW), larger values apply.



P108	Disconnection mode *(Disconnection mode)*		S	P

0 ... 13
{ 1 }

This parameter determines the manner in which the output frequency is reduced after "Blocking" (controller enable → Low).

0 = Block voltage: The output signal is switched off immediately. The FI no longer supplies an output frequency. The motor is only braked by mechanical friction. Switching the FI on again immediately can lead to an error message.

1 = Ramp: The current output frequency is reduced in proportion to the remaining deceleration time, from P103/P105. The DC run-on follows the end of the ramp (→ P559).

2 = Ramp with delay: as for 1 **"Ramp"**, however for generational operation the brake ramp is extended, or for static operation the output frequency is increased. Under certain conditions, this function can prevent overload switch off or reduce brake resistance power dissipation.

NOTE: This function must not be programmed if defined deceleration is required, e.g. with lifting mechanisms.

3 = Immediate DC braking: The FI switches immediately to the preselected DC current (P109). This DC current is supplied for the remaining proportion of the >DC brake time< (P110). Depending on the relationship, actual output frequency to max. frequency (P105), the >Time DC brake on< is shortened. The time taken for the motor to stop depends on the application. The time taken to stop depends on the mass inertia of the load and the DC current set (P109).
With this type of braking, no energy is returned to the FI; heat loss occurs mainly in the motor rotor.

Not for PMSM motors!

4 = Const. brake distance, *"Constant brake distance"*: The brake ramp is delayed in starting if the equipment is not being driven at the maximum output frequency (P105). This results in an approximately similar braking distance for different frequencies.

NOTE: This function cannot be used as a positioning function. This function should not be combined with ramp smoothing (P106).

5 = Combined braking, *"Combined braking"*: Dependent on the actual link voltage (UZW), a high frequency voltage is switched to the basic frequency (only for linear characteristic curves, P211 = 0 and P212 = 0). The braking time (P103) is complied with if possible. → Additional heating in the motor!

Not for PMSM motors!

6 = Quadratic ramp: The brake ramp does not follow a linear path, but rather a decreasing quadratic one.

7 = Quad. ramp with delay, *"Quadratic ramp with delay"***:** Combination of functions 2 and 6

8 = Quad. comb. braking, *"Quadratic combined braking"*: Combination of functions 5 and 6

Not for PMSM motors!

9 = Const. acceln. power, *"Constant acceleration power"*: Only applies in field weakening range! The drive is accelerated or braked using constant electrical power. The course of the ramps depends on the load.

10 = Distance calculator: Constant distance between actual frequency / speed and the set minimum output frequency (P104).

11 = Const. acceln. power with delay**,** *"Constant acceleration power with delay"*: Combination of functions 2 and 9.

12 = Const. acceln. power mode 3, *"Constant acceleration power mode 3"* as for 11, however with additional relief of the brake chopper

13 = Disconnection delay, *„"Ramp with disconnection delay"*: as for 1 **"Ramp"**, however, before the brake is applied, the drive unit remains at the absolute minimum frequency set in parameter (P505) for the time specified in parameter (P110)**.**
Application example: Re-positioning for crane control

P109	DC brake current *(DC brake current)*		S	P

0 ... 250 %
{ 100 }

Current setting for the functions of DC current braking (P108 = 3) and combined braking (P108 = 5).

The correct setting value depends on the mechanical load and the required deceleration time. A higher setting brings large loads to a standstill more quickly.

The 100% setting relates to a current value as stored in the >Nominal current< parameter P203.

NOTE: The amount of DC current (0 Hz) which the FI can supply is limited. For this value, please refer to the table in Section (chapter 8.4.3), column: 0 Hz. In the basic setting this limiting value is about 110 %.

DC braking Not for PMSM motors!

P110	Time DC-brake on *(DC braking time on)*		S	P

0.00 ... 60.00 sec
{ 2.00 }

The time during which current selected in parameter P109 is applied to the motor for the function "DC braking" selected in parameter P108 (P108 = 3).

Depending on the relationship of the actual output frequency to the max. frequency (P105), the >DC brake time< is shortened.

The time starts running with the removal of the enable and can be interrupted by fresh enabling.

DC braking Not for PMSM motors!

P111	P factor torque limit *(P factor torque limit)*		S	P

25 ... 400 %
{ 100 }

Directly affects the behaviour of the drive at torque limit. The basic setting of 100% is sufficient for most drive tasks.

If values are too high the drive tends to vibrate as it reaches the torque limit. If values are too low, the programmed torque limit can be exceeded.

P112	Torque current limit *(Torque current limit)*		S	P

25 ... 400% / 401
{ 401 }

With this parameter, a limit value for the torque-generating current can be set. This can prevent mechanical overloading of the drive. However, it cannot provide protection against mechanical blockages (moving on block). A slipping clutch, which acts as a safety device is not replaceable.

The torque current limit can also be set over a continuous range of settings using an analogue input. The maximum setpoint (cf. adjustment 100%, P403/P408) then corresponds to the setting value in P112.

The limit value 20% of torque current cannot be undershot by a smaller analogue setpoint (P400/405 = 2). However, with **servo mode** with P300 = 1 the following applies:

- Software version 1.9 and lower: not below 10%
- Software version 2.0 and higher: no restrictions (possible from 0% motor torque)!

401 = OFF indicates the switch-off of the torque current limit! At the same time, this is the basic setting of the frequency inverter.

NOTE: In lifting gear applications, the torque limit is to be omitted!

NOTE: In VFC and CFC open-loop modes of the PMSM, a torque limit is set by force, if none has been programmed in parameter P112, or if the set value is greater than the following limit values:

VFC open-loop: Setting value from P210 + max. 30%

CFC open-loop: Setting value from P210 + max. 50%

P113	Jog frequency *(Jog frequency)*		S	P

-400.0 ... 400.0 Hz
{ 0.0 }
Change of function as of software version 1.7

When using the **ControlBox or ParameterBox** to control the FI, the jog frequency is the initial value following successful enabling.

Alternatively, when control is via the control terminals, the jog frequency can be activated via one of the digital inputs.

The setting of the jog frequency can be done directly via this parameter or, if the FI is enabled via the keyboard, by pressing the ENTER key. In this case, the actual output frequency is set in parameter P113 and is then available for the next start.

NOTE: **Software version V1.7 R0 and higher:**

The activation of the jog frequency via one of the digital inputs causes the remote control to be switched off in case of bus operation. In addition, any setpoint frequencies present are not taken into account.
Exception: analog setpoint values which are processed via the functions Frequency addition or Frequency subtraction.

Up to software version V1.6 R1:

Specified setpoints via the control terminals, e.g. jog frequency, fixed frequencies or analog setpoints, are generally added with the correct sign. The set maximum frequency (P105) cannot be exceeded and the minimum frequency (P104) cannot be undershot.

P114	Brake delay off *(Brake release time)*		S	P

0 ... 2.50 s
{ 0.00 }

Electromagnetic brakes have a delayed reaction time during ventilation, which depends on physical factors. This can lead to the motor running while the brake is still applied, which will cause the inverter to switch off with an overcurrent report.

This release time can be taken into account in parameter P114 (Brake control).

During the adjustable ventilation time, the FI supplies the set absolute minimum frequency (P505) thus preventing movement against the brake.

See also the parameter >Brake reaction time< P107 (setting example).

NOTE:

If the brake ventilation time is set to "0", then P107 is the brake ventilation and reaction time.

P120	[-01] ... [-04]	Option monitoring *(Option monitoring)*		S	

0 ... 2
{ 1 }

Monitoring of communication at system bus level (in case of error: error message 10.9)

Array levels:

[-01] = Extension 1 (BUS unit)
[-02] = Extension 2 *(second I/O unit)*
[-03] = Extension 3 *(first I/O unit)*
[-04] = Extension 4 (reserved)

Setting values

0 = **Monitoring OFF**

1 = **Auto**, communication is only monitored if an existing communication is interrupted. If a module which was previously present is not found after switching on the mains, this does not result in an error
Monitoring only becomes active when an extension starts communication with the FI.

2 = **Monitoring active immediately** *"Monitoring active immediately"* , the FI starts monitoring the corresponding module immediately after the mains are switched on. If the module is not detected on switch-on, the FI remains in the status "not ready for switch-on" for 5 seconds and then triggers an error message.

Note: If error messages which are detected by the optional module (e.g. errors at field bus level) are not to result in a shut-down of the drive electronics, parameter (P513) must also be set to the value {-0,1}.

Information **Option monitoring P120**

Optional monitoring (P120) is only function for option modules which are connected via the system bus (e.g. I/O extensions).

This parameter can not be used for TU3 modules. In this case, monitoring via parameter P513 is possible.

5.1.3 Motor data / Characteristic curve parameters

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set
P200	**Motor list** *(Motor list)*			**P**

0 ... 73
{ 0 }

The factory settings for the motor data can be edited with this parameter. A 4-pole IE1 three-phase standard motor with the FI nominal power is factory-set in parameters **P201 ... P209**.

By selecting one of the possible digits and pressing the ENTER key, all of the motor parameters (**P201 ... P209**) are matched to the selected motor power. The motor data is based on a 4-pole three-phase standard motor.

Note:

As **P200** is = 0 again after input acknowledgement, the set motor can be controlled via parameter **P205**.

Information

If IE2/IE3 motors are used, after selecting an IE1 motor (**P200**), the motor data in **P201 … P209** must be adapted to the data on the motor name plate.

0 = **No change**

1 = **No motor:** In this setting, the FI operates without current control, slip compensation and pre-flux delay, and is therefore not recommended for controlling motors. Potential applications include induction furnaces or other applications with coils or transformers. The following motor data is set here: 50.0 Hz / 1500 rpm / 15.0 A / 400 V / 0.00 kW / cos φ=0.90 / Star / R_S 0.01 Ω / I_{LEER} 6.5 A

IE1 motors:

2 =	0.25kW 230V	**26 =**	2.2kW 230V	**50 =**	22.0kW 400V	**74 =**	11.0kW 230V
3 =	0.33PS 230V	**27 =**	3.0PS 230V	**51 =**	30.0PS 460V	**75 =**	15.0PS 230V
4 =	0.25kW 400V	**28 =**	2.2kW 400V	**52 =**	30.0kW 400V	**76 =**	15.0kW 230V
5 =	0.33PS 460V	**29 =**	3.0PS 460V	**53 =**	40.0PS 460V	**77 =**	20.0PS 230V
6 =	0.37kW 230V	**30 =**	3.0kW 230V	**54 =**	37.0kW 400V	**78 =**	18.5kW 230V
7 =	0.50PS 230V	**31 =**	3.0kW 400V	**55 =**	50.0PS 460V	**79 =**	25.0PS 230V
8 =	0.37kW 400V	**32 =**	4.0kW 230V	**56 =**	45.0kW 400V	**80 =**	22.0kW 230V
9 =	0.50PS 460V	**33 =**	5.0PS 230V	**57 =**	60.0PS 460V	**81 =**	30.0PS 230V
10 =	0.55kW 230V	**34 =**	4.0kW 400V	**58 =**	55.0kW 400V	**82 =**	30.0kW 230V
11 =	0.75PS 230V	**35 =**	5.0PS 460V	**59 =**	75.0PS 460V	**83 =**	40.0PS 230V
12 =	0.55kW 400V	**36 =**	5.5kW 230V	**60 =**	75.0kW 400V	**84 =**	37.0kW 230V
13 =	0.75PS 460V	**37 =**	7.5PS 230V	**61 =**	100.0PS 460V	**85 =**	50.0PS 230V
14 =	0.75kW 230V	**38 =**	5.5kW 400V	**62 =**	90.0kW 400V	**86 =**	0.12kW 115V
15 =	1.0PS 230V	**39 =**	7.5PS 460V	**63 =**	120.0PS 460V	**87 =**	0.18kW 115V
16 =	0.75kW 400V	**40 =**	7.5kW 230V	**64 =**	110.0kW 400V	**88 =**	0.25kW 115V
17 =	1.0PS 460V	**41 =**	10.0PS 230V	**65 =**	150.0PS 460V	**89 =**	0.37kW 115V
18 =	1.1kW 230V	**42 =**	7.5kW 400V	**66 =**	132.0kW 400V	**90 =**	0.55kW 115V
19 =	1.5PS 230V	**43 =**	10.0PS 460V	**67 =**	180.0PS 460V	**91 =**	0.75kW 115V
20 =	1.1kW 400V	**44 =**	11.0kW 400V	**68 =**	160.0kW 400V	**92 =**	1.00kW 115V
21 =	1.5PS 460V	**45 =**	15.0PS 460V	**69 =**	220.0PS 460V	**93 =**	4.0PS 230V
22 =	1.5kW 230V	**46 =**	15.0kW 400V	**70 =**	200.0kW 400V	**94 =**	4.0PS 460V
23 =	2.0PS 230V	**47 =**	20.0PS 460V	**71 =**	270.0PS 460V		
24 =	1.5kW 400V	**48 =**	18.5kW 400V	**72 =**	250.0kW 400V		
25 =	2.0PS 460V	**49 =**	25.0PS 460V	**73 =**	340.0PS 460V		

IE4 motors

95 =	0.75 kW, 230 V, 80T1/4	**102 =**	1.50 kW, 400 V, 80T1/4	**109 =**	3.00 kW, 400 V, 100T2/4
96 =	1.10 kW, 230 V, 90T1/4	**103 =**	2.20 kW, 230 V, 100T2/4	**110 =**	3.00 kW, 400 V, 90T3/4
97 =	1.10 kW, 230 V, 80T1/4	**104 =**	2.20 kW, 230 V, 90T3/4	**111 =**	4.00 kW, 230 V, 100T5/4
98 =	1.10 kW, 400 V, 80T1/4	**105 =**	2.20 kW, 400 V, 90T3/4	**112 =**	4.00 kW, 400 V, 100T5/4
99 =	1.50 kW, 230 V, 90T3/4	**106 =**	2.20 kW, 400 V, 90T1/4	**113 =**	4.00 kW, 400 V, 100T2/4
100 =	1.50 kW, 230 V, 90T1/4	**107 =**	3.00 kW, 230 V, 100T5/4	**114 =**	5.50 kW, 400 V, 100T5/4
101 =	1.50 kW, 400 V, 90T1/4	**108 =**	3.00 kW, 230 V, 100T2/4		

IE5 motors

117 =	0.35 kW, 400 V, 71N1/8	**125 =**	1.50 kW, 400 V, 90F1/8	**139 =**	1.05 kW, 230 V, 71N3/8
118 =	0.50 kW, 400 V, 71F1/8	**126 =**	2.20 kW, 400 V, 71F4/8	**140 =**	1.10 kW, 230 V, 90N1/8
119 =	0.70 kW, 400 V, 71N2/8	**127 =**	2.20 kW, 400 V, 90N3/8	**143 =**	1.50 kW, 230 V, 90N2/8
120 =	1.00 kW, 400 V, 71F2/8	**128 =**	2.20 kW, 400 V, 90F2/8	**145 =**	2.20 kW, 230 V, 90N3/8
121 =	1.05 kW, 400 V, 71N3/8	**129 =**	3.00 kW, 400 V, 90F3/8		
122 =	1.10 kW, 400 V, 90N1/8	**130 =**	3.70 kW, 400 V, 90F4/8		
123 =	1.50 kW, 400 V, 71F3/8	**135 =**	0.35 kW, 230 V, 71N1/8		
124 =	1.50 kW, 400 V, 90N2/8	**137 =**	0.70 kW, 230 V, 71N2/8		

P201 — Nominal frequency

(Nominal frequency)

S | P

10.0 … 399.9 Hz
{ see information }

The motor frequency determines the V/f break point at which the FI supplies the nominal voltage (**P204**) at the output.

Information

Default setting

The default setting depends on the nominal power of the FI and the setting in **P200**.

P202 — Nominal speed

(Nominal speed)

S | P

150 … 24000 rpm
{ see information }

The nominal motor speed is important for correct calculation and control of the motor slip and the speed display (**P001 = 1**).

Information

Default setting

The default setting depends on the nominal power of the FI and the setting in **P200**.

P203 — Nominal current

(Nominal current)

S | P

0.1 … 1000.0 A
{ see information }

The nominal motor current is a decisive parameter for current vector control.

Information

Default setting

The default setting depends on the nominal power of the FI and the setting in **P200**.

P204 — Nominal voltage

(Nominal voltage)

S | P

100 ... 800 V
{ see information }

This parameter sets the nominal voltage. The combination with the nominal frequency results in the voltage/frequency characteristic curve.

Information

Default setting

The default setting depends on the nominal power of the FI and the setting in **P200**.

P205	**Nominal power** *(Nominal power)*			P
0.00 … 250.00 kW { see information }	The motor nominal power controls the motor set via **P200**. **Information** **Default setting** The default setting depends on the nominal power of the FI and the setting in **P200**.			

P206	**Cos phi** *(Cos φ)*		S	P
0.50 ... 0.98 { see information }	The motor cos φ is a decisive parameter for current vector control. **Information** **Default setting** The default setting depends on the nominal power of the FI and the setting in **P200**.			

P207	**Star Delta con.** *(Star Delta con.)*		S	P
0 … 1 { see information }	**0 = Star** **1 = Delta** The motor circuit is decisive for stator resistance measurement (**P220**) and therefore for current vector control. **Information** **Default setting** The default setting depends on the nominal power of the FI and the setting in **P200**.			

P208	**Stator resistance** *(Stator resistance)*		S	P
0.00 … 300.00 Ω { see information }	Motor stator resistance ⇒ Resistance of a phase winding with a three-phase motor. Has a direct influence on the current control of the FI. A value which is too high may result in overcurrent; a value which is too low may result in low motor torque. Parameter **P220** can be used for simple measurement. Parameter **P208** can be used for manual setting or as information on the automatic measurement result. **Note**: For optimum functioning of the current vector control, the stator resistance must be measured automatically by the FI. **Information** **Default setting** The default setting depends on the nominal power of the FI and the setting in **P200**.			

P209	**No-load current** *(No-load current)*		S	P
0.0 … 1000.0 A { see information }	This value is always calculated automatically from the motor data if there is a change in the parameter **P206** “cos φ” and parameter **P203** “Nominal current”. **Note**: If the value is to be entered directly, then it must be set as the last value of the motor data. This is the only way to ensure that the value will not be overwritten. **Information** **Default setting** The default setting depends on the nominal power of the FI and the setting in **P200**.			

P210	Static boost *(Static boost)*		S	P
0 ... 400% { 100 }	The static boost affects the current, which generates the magnetic field. This corresponds to the no-load current of the respective motor and therefore does not depend on the load. The no-load current is calculated using the motor data. The 100% factory setting is sufficient for typical applications.			

P211	Dynamic boost *(Dynamic boost)*		S	P
0 ... 150 % { 100 }	The dynamic boost affects the torque generating current and is therefore a load-dependent parameter. The factory 100% setting is also sufficient for typical applications. Too high a value can lead to overcurrent in the FI. Under load therefore, the output voltage will be raised too sharply. Too low a value will lead to insufficient torque.			

Information — **U/f – characteristic curve**

For certain applications, particularly those with high centrifugal masses (e.g. fan drives) it may necessary to control the motor using a U/f characteristic curve. For this, parameters **P211** and **P212** must each be set to 0%.

P212	Slip compensation *(Slip compensation)*		S	P
0 ... 150% { 100 }	The slip compensation increases the output frequency, dependent on load, to keep the asynchronous motor speed approximately constant. The factory setting of 100% is optimal when using DC asynchronous motors and correct motor data has been set. If several motors (different loads or outputs) are operated with one FI, the slip compensation P212 must be set to 0%. This excludes any negative influences. With PMSM motors, the parameter must be left at the factory setting.			

Information — **U/f – characteristic curve**

For certain applications, particularly those with high centrifugal masses (e.g. fan drives) it may necessary to control the motor using a U/f characteristic curve. For this, parameters **P211** and **P212** must each be set to 0%.

Information — **PMSM**

When controlling a PMSM, this parameter determines the voltage of the test signal principal (**P330**). The required voltage depends on various factors (ambient and motor temperature, motor size, motor cable length, size of frequency inverter and others). If the rotor position identification is not successful, this parameter can be used to adjust the voltage.

P213	ISD ctrl. loop gain *(Amplification of ISD control)*		S	P
25 ... 400 % { 100 }	This parameter influences the control dynamics of the FI current vector control (ISD control). Higher settings make the controller faster, lower settings slower. Dependent on application type, this parameter can be altered, e.g. to avoid unstable operation.			

P214	Torque precontrol *(Torque precontrol)*		S	P
-200 ... 200 % { 0 }	This function allows a value for the expected torque requirement to be set in the controller. This function can be used in lifting applications for a better load transfer during start-up. **NOTE:** Motor torques (with rotation field right) are entered with a positive sign, generator torques are entered with a negative sign. The reverse applies for the counter clockwise rotation.			

P215	**Boost precontrol** *(Boost precontrol)*		S	P
0 ... 200 % { 0 }	Only advisable with linear characteristic curve (P211 = 0% and P212 = 0%). For drives that require a high starting torque, this parameter provides an option for switching in an additional current during the start phase. The application time is limited and can be selected at parameter >Time boost precontrol< P216. All current and torque current limits that may have been set (P112 and P536, P537) are deactivated during the boost lead time. **NOTE:** With active ISD control (P211 and / or P212 ≠ 0%), parameterisation of P215 ≠ 0 results in incorrect control.			

P216	**Time boost precontrol** *(Time boost precontrol)*		S	P
0.0 ... 10.0 sec { 0.0 }	This parameter is used for 3 functionalities **Time limit** for the **boost lead**: Application time for increased starting current. Only with linear characteristic curve (P211 = 0% and P212 = 0%). **Time limit** for **suppression of** pulse **switch-off** (P537): enables start-up under heavy load. **Time limit** for **suppression** of **switch-off on error** in parameter (P401), setting { 05 } "0 - 10V with switch-off on error 2"			

P217	**Oscillation damping** *(Oscillation damping)*		S	P
0 ... 400 % { 10 }	With the oscillation damping, idling current harmonics can be damped. Parameter 217 is a measure of the damping power. For oscillation damping the oscillation component is filtered out of the torque current by means of a high pass filter. This is amplified by P217, inverted and switched to the output frequency. The limit for the value switched is also proportional to P217. The time constant for the high pass filter depends on P213. For higher values of P213 the time constant is lower. With a set value of 10 % for P217, a maximum of ± 0.045 Hz are switched in. At 400 % in P217, this corresponds to ± 1.8 Hz The function is not active in “Servo mode, P300”.			

P218	**Modulation depth** *(Modulation depth)*		S	
50 ... 110 % { 100 }*e*	This setting influences the maximum possible output voltage of the FI in relation to the mains voltage. Values <100% reduce the voltage to values below that of the mains voltage if this is required for motors. Values >100% increase the output voltage to the motor increased the harmonics in the current, which may cause swinging in some motors. Normally, 100% should be set.			

P219	Automatic flux optimisation *(Automatic flux optimisation)*		S	

25 ... 100 % / 101
{ 100 }

With this parameter, the magnetic flux of the motor can be automatically matched to the motor load, so that the energy consumption is reduced to the amount which is actually required. P219 is a limiting value, to which the field in the motor can be reduced.

As standard, the value is set to 100 %, and therefore no reduction is possible. As minimum, 25 % can be set.

The reduction of the field is performed with a time constant of approx. 7.5 s. On increase of load the field is built up again with a time constant of approx. 300 ms. The reduction of the field is carried out so that the magnetisation current and the torque current are approximately equal, so that the motor is operated with “optimum efficiency”. An increase of the field above the setpoint value is not intended.

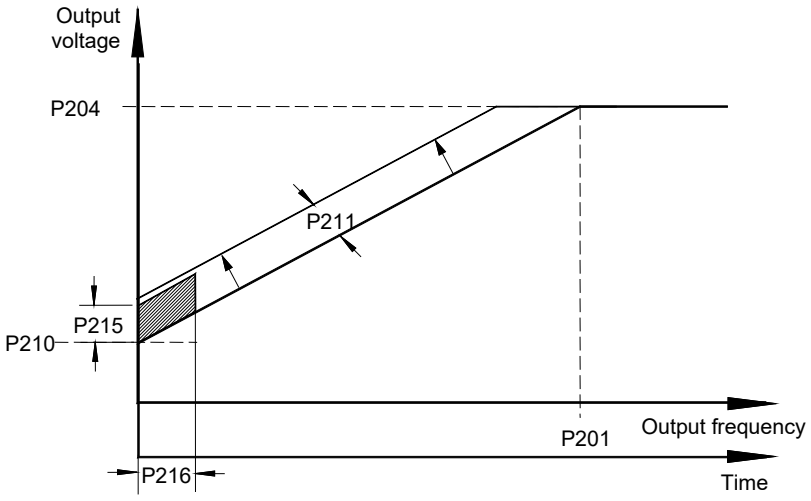
This function is intended for applications in which the required torque only changes slowly (e.g. pumps and fans). Its effect therefore replaces a quadratic curve, as it adapts the voltage to the load.

This parameter does not function for the operation of synchronous motors (IE4 motors).

NOTE: This must not be used for lifting or applications where a more rapid build-up of the torque is required, as otherwise there would be overcurrent switch-offs or inversion of the motor on sudden changes of load, because the missing field would have be compensated by a disproportionate torque current.

101 = automatic, with the setting P219 = 101 an automatic magnetisation current controller is activated. The ISD controller then operates with a subordinate magnetizing controller, which improves the slippage calculation, especially at higher loads. The control times are considerably faster compared to the Normal ISD control (P219 = 100)

P2xx Control/characteristic curve parameters



NOTE:
"typical"

Settings for the...	**Current vector control** (factory setting)	**Linear V/f characteristic curve**
	P201 to P209 = Motor data	P201 to P209 = Motor data
	P210 = 100%	P210 = 100% (static boost)
	P211 = 100%	P211 = 0%
	P212 = 100%	P212 = 0%
	P213 = 100%	P213 = no significance
	P214 = 0%	P214 = no significance
	P215 = no significance	P215 = 0% (boost precontrol)
	P216 = no significance	P216 = 0s (time dyn. boost)

P220	Par.-identification *(Parameter identification)*			P

0 … 2
{ 0 }

For devices with an output up to 7.5 kW (230 V ≤ 4.0 kW), the motor data is determined automatically by the device via this parameter. In many cases, better drive behaviour is achieved with the calibrated motor data.

The identification of all parameters may take some time. During this time, **do not switch of the mains voltage**. If there is unfavourable operating behaviour after identification, select a suitable motor in P200 or set parameters P201 ... P208 manually.

0 = No identification

1 = R_S identification :

The stator resistance (display in P208) is determined by multiple measurements.

2 = Motor identification:

This function can only be used with devices up to 7.5 kW (230 V ≤ 4.0 kW).

ASM: All motor parameters (P202, P203, P206, P208, P209) are determined.

PMSM: Stator resistance (P208) and inductivity (P241) are determined.

Note: Motor data identification should only be carried out with a cold motor (15 … 25 °C). Warming of the motor during operation is taken into account.

The FI must be in “Ready for operation” state. For BUS operation, the BUS must be operating without error.

The motor power may only be one power level greater or three power levels lower than the nominal power of the FI.

A maximum motor cable length of 20 m must be complied with for reliable identification.

Before starting motor identification, the motor data must be pre-set according to the name plate or P200. At least the nominal frequency (P201), the nominal speed (P202), the voltage (P204), the power (P205) and the star delta con. (P207) must be known.

Care must be taken that the connection to the motor is not interrupted during the entire measuring process.

If the identification cannot be completed successfully, error message E019 is generated.

After parameter identification, P220 is 0 again.

P240	EMF voltage PMSM *(EMF voltage PMSM)*		S	P

0 … 800 V
{ 0 }

The EMF constant describes the self induction voltage of the motor. The value to be set can be found on the data sheet for the motor or on the type plate and is scaled to 1000 rpm. As the rated speed of the motor is not usually 1000 rpm, these details must be converted accordingly:

Example:

E (EMF - constant, type plate):	89 V
Nn (rated speed of motor):	2100 rpm
Value in P240	P240 = E * Nn/1000 P240 = 89 V * 2100 rpm / 1000 rpm **P240 = 187 V**

0 = ASM is used, *"Asynchronous machine is used"*: No compensation

P241 [-01] [-06]	Inductivity PMSM *(Inductivity PMSM)*		S	P

0.1 ... 200.0 mH
{ all 20.0 }

The stator inductivity of the d or q component of a permanently excited synchronous motor (PMSM). The frequency inverter can calibrate the stator inductivities (P220).

[-01] = Ld **[-02] = Lq**

[-03] = Unsaturated Ld **[-04] = Unsaturated Lq**

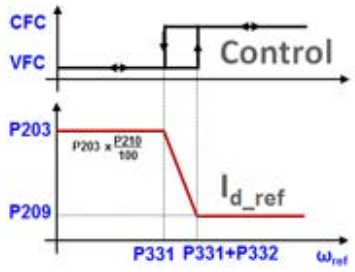
[-05] = Saturated Ld **[-06] = Saturated Lq**

P243	Reluct. angle IPMSM *(Reluctance angle IPMSM)*		S	P
0 … 30° { 0 }	In addition to the synchronous torque, synchronous machines with embedded magnets also have a reluctance torque. This is due to the anisotropy (imbalance) between the inductivity in the d and the q direction. Due to the superimposition of these two torque components, the maximum efficiency is not at a load angle of 90° as with SPMSMs, but of rather larger values. This additional angle can be taken into account with this parameter. The smaller the angle, the smaller the reluctance proportion. The specific reluctance angle for the motor can be determined as follows: • Allow drive with constant load (> 0.5 M_N) to run in CFC mode (P300 ≥ 1) • Gradually increase the reluctance angle (P243) until the current (P719) is at its minimum			

P244 [-01] [-05]	Peak current PMSM *(Peak current PMSM)*		S	P
-20.0 … 1000.0 A { 5.0 }	For PMSMs with non-linear characteristic induction curves, the linearity limits can be entered with parameter **P244 [-02] – [-05]**. For NORD PMSMs (IE4 and IE5⁺ motors) the necessary data is stored if the motor is selected in **P200**. **[-01] = Peak current PMSM** **[-02] = I_{max} unsaturated Ld** **[-03] = I_{max} unsaturated Lq** **[-04] = I_{min} saturated Ld** **[-05] = I_{min} saturated Lq**			

P245	Osc damping .PMSM VFC *(Oscillation damping PMSM VFC)*		S	P
5 … 250 % { 25 }	In VFC open-loop mode, PMSM motors tend to oscillate due to insufficient intrinsic damping. With the aid of "oscillation damping" this tendency to oscillate is counteracted by electrical damping.			

P246	Mass inertia PMSM *(Mass inertia PMSM)*		S	P
0.0 … 1000.0 kg*cm² { 5.0 }	The mass inertia of the drive system can be entered in this parameter. For most applications the default setting is sufficient. However, for highly dynamic systems the actual value should ideally be entered. The values for the motors can be obtained from the technical data. The portion of the external centrifugal mass (gear unit, machine) must be calculated or determined experimentally.			

P247	Switch freq.VFC PMSM *(Switchover frequency VFC PMSM)*		S	P
1 ... 100 % { 25 }	In order to provide a minimum amount of torque immediately in case of spontaneous load changes, in VFC mode the setpoint of I_d (magnetisation current) is controlled depending on the frequency (field increase mode) The amount of this additional field current is determined by parameter (P210). This reduces linearly to the value "zero", which is reached at the frequency which is governed by (P247). In this case, 100 % corresponds to the rated motor frequency from (P201).			

5.1.4 Control parameters

Only available above SK 520E with the use of an incremental encoder.

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set
P300	**Servo Mode** *(Servo Mode)*			**P**
0 ... 2 { 0 }	The control method for the motor is defined with this parameter. The following constraints must be observed: In comparison with the setting "0", the setting "2" enables somewhat higher dynamics and control precision, however it requires greater effort for parameterisation. In contrast, the setting "1" operates with speed feedback from an encoder and therefore enables the highest possible quality of speed control and dynamics. **0 = Off (VFC open -loop)** [1] Speed control without encoder feedback **1 = On (CFC closed-loop)** [2] Speed control with encoder feedback **2 = Obs (CFC open-loop)** Speed control without encoder feedback **NOTE:** Commissioning information (📖 Abschnitt 4.2 "Selecting the operating mode for motor control"). 1) Corresponds to the previous setting "OFF" 2) Corresponds to the previous setting "ON" **Information** **Operation of a synchronous motor with P300 {1} = On (CFC closed-loop)** When operating a synchronous motor in the CFC closed-loop mode, the slip error monitoring must be activated (**P327 ≠ 0 and P328 ≠ 0.0**).			
P301	**Rotary encoder res.** *(Rotary encoder resolution)*			
0 ... 17 { 6 }	Input of the pulse-count per rotation of the connected encoder. If the encoder rotation direction is not the same as the FI, (depending on installation and wiring), this can be compensated for by selecting the corresponding negative pulse numbers 8...16. **0 =** 500 pulses **1 =** 512 pulses **2 =** 1000 pulses **3 =** 1024 pulses **4 =** 2000 pulses **5 =** 2048 pulses **6 =** 4096 pulses **7 =** 5000 pulses **17 =** 8192 pulses **8 =** -500 pulses **9 =** -512 pulses **10 =** -1000 pulses **11 =** -1024 pulses **12 =** -2000 pulses **13 =** -2048 pulses **14 =** -4096 pulses **15 =** -5000 pulses **16 =** -8192 pulses **NOTE:** (P301) is also significant for position control via incremental encoders. If an incremental encoder is used for positioning (P604=1), the setting of the pulse number is made here. (Please refer to POSICON Supplementary Manual)			
P310	**Speed controller P** *(Speed controller P)*			**P**
0 ... 3200 % { 100 }	P-component of the speed encoder (proportional amplification). Amplification factor, by which the speed difference between the setpoint and actual frequency is multiplied. A value of 100% means that a speed difference of 10% produces a setpoint of 10%. Values that are too high can cause the output speed to oscillate.			

P311	Speed controller I *(Speed controller I)*			P
0 ... 800 % / ms { 20 }	I-component of the encoder (Integration component). The integration component of the controller enables the complete elimination of any control deviation. The value indicates how large the setpoint change is per ms. Values that are too small cause the controller to slow down (reset time is too long).			

P312	Torque current controller P *(Torque current controller P)*		S	P
0 ... 1000 % { 400 }	Current controller for the torque current. The higher the current controller parameters are set, the more precisely the current setpoint is maintained. Excessively high values in P312 generally lead to high-frequency oscillations at low speeds; on the other hand, excessively high values in P313 generally produce low frequency oscillations across the whole speed range. If the value "Zero" is entered in P312 and P313, then the torque current control is switched off. In this case, only the motor model pre-control is used.			

P313	Torque current controller I *(Torque current controller I)*		S	P
0 ... 800 % / ms { 50 }	I-proportion of the torque current controller. (See also P312 >Torque current controller P<)			

P314	Torque current controller limit *(Torque current controller limit)*		S	P
0 ... 400 V { 400 }	Determines the maximum voltage increase of the torque current controller. The higher the value, the greater the maximum effect that can be exercised by the torque current controller. Excessive values in P314 can specifically lead to instability during transition to the field weakening zone (see P320). The values for P314 and P317 should always be set roughly the same, so that the field and torque current controllers are balanced.			

P315	Field current controller P *(Field current controller P)*		S	P
0 ... 1000 % { 400 }	Current controller for the field current. The higher the current controller parameters are set, the more precisely the current setpoint is maintained. Excessively high values for P315 generally lead to high frequency vibrations at low speeds. On the other hand, excessively high values in P316 generally produce low frequency vibrations across the whole speed range If the value "Zero" is entered in P315 and P316, then the field current controller is switched off. In this case, only the motor model pre-control is used.			

P316	Field current controller I *(Field current controller I)*		S	P
0 ... 800 % / ms { 50 }	I-proportion of the field current controller. See also P315 >Field current controller P<			

P317	Field current controller limit *(Field current controller limit)*		S	P
0 ... 400 V { 400 }	Determines the maximum voltage increase of the field current controller. The higher the value, the greater is the maximum effect that can be exercised by the field current controller. Excessive values in P317 can specifically lead to instability during transition to the field reduction range (see P320). The values for P314 and P317 should always be set roughly the same, so that the field and torque current controllers are balanced.			

P318	**Field weakening controller P** *(Field weakening controller P)*		S	P
0 ... 800 % { 150 }	The field weakening controller reduces the field setpoint when the synchronous speed is exceeded. Generally, the field weakening controller has no function; for this reason, the field weakening controller only needs to be set if speeds are set above the nominal motor speed. Excessive values for P318 / P319 will lead to controller oscillations. The field is not weakened sufficiently if the values are too small or during dynamic acceleration and/or delay times. The downstream current controller can no longer read the current setpoint.			

P319	**Field weakening controller I** *(Field weakening controller I)*		S	P
0 ... 800 % / ms { 20 }	Only affects the field weakening range, see P318 >Field weakening controller P<			

P320	**Field weakening limit** *(Field weakening limit)*		S	P
0 ... 110 % { 100 }	The field weakening limit determines at which speed / current the controller will begin to weaken the field. At a set value of 100% the controller will begin to weaken the field at approximately the synchronous speed. If values much larger than the standard values have been set in P314 and/or P317, then the field weakening limit should be correspondingly reduced, so that the control range is actually available to the current controller.			

P321	**Speedctr. I brake off** *(Speed control I brake release time)*		S	P
0 ... 4 { 0 }	During the brake release time (P107/P114), the I component of the speed control is increased. This leads to better load take-up, especially with vertical movements. **0 =** P311 speed control I x 1 **1 =** P311 speed control I x 2 **2 =** P311 speed control I x 4 **3 =** P311 speed control I x 8 **4 =** P311 speed control I x 16			

P325	**Rotary encoder function** *(Rotary encoder function)*			
0 ... 4 { 0 }	The actual speed list value supplied by an incremental encoder to the FI can be used for various functions in the FI. **0 = Speed measurement Servo mode,** *"Servo mode speed measurement"*: The actual motor speed list value is used for the FI servo mode. The ISD control cannot be switched off in this function. **1 = PID actual frequency value**: The actual speed of a system is used for speed control. This function can also be used for controlling a motor with a linear characteristic curve. It is also possible to use an incremental encoder for speed control which is not mounted directly onto the motor. P413 – P416 determine the control. **2 = Frequency addition**: The determined speed is added to the actual setpoint value. **3 = Frequency subtraction**: The determined speed is subtracted from the actual setpoint. **4 = Maximum frequency**: The maximum possible output frequency / speed is limited by the speed of the encoder.			

P326	**Ratio encoder** *(Encoder transformation ratio)*			
0.01 ... 100.00 { 1.00 }	If the incremental encoder is not mounted directly onto the motor shaft, then the respectively correct transformation ratio of motor speed to encoder speed must be set. $P326 = \frac{\text{Motor speed}}{\text{Encoder speed}}$ Only when P325 = 1, 2, 3 or 4, therefore not in Servo mode (motor speed control)			

P327 Speed slip error

(Slip error Speed controller)

0 ... 3000 rpm
{ 0 }

The limit value for a permitted maximum slip error can be set. If this limit value is reached, the frequency inverter switches off and displays error E013.1. The slip error monitoring works with active and inactive servo mode (P300).

0 = OFF

Relevant settings

Encoder type	Electrical connection	Parameter
TTL encoder	Encoder interface (X6 terminals)	P325 = 0
HTL encoder	DIN2 (X5:22 terminal) …	P420 [-02] or P421 = 43
	DIN4 (X5:24 terminal) …	P420 [-04] or P423 = 44
		P461 = 0

Note:

If a PMSM is operated in close-loop mode and no slip error limit has been programmed in parameter P327/P328, a mandatory limit is activated. The permissible slip error limit is 500 rpm; the permissible time of exceedance is 500 ms. As soon as a limit has been programmed, the programmed values will also be used.

P328 Speed slip delay

(Speed slip error delay)

0.0 ... 10.0 sec
{ 0.0 }
above SW 2.0

If the permissible speed slip error defined in (P327) is exceeded the error message E013.1 is suppressed within the time limits which are set here.

0.0 = OFF

P330 Rotor starting position detection

(Rotor starting position detection)

(Former designation: "**PMSM Regulation** ")

S

0 ... 7
{ 1 }

Selection of the method for determination of the starting position of the rotor (initial value of the rotor position) of a PMSM (Permanent Magnet Synchronous Motor).

The parameter is only relevant for the control method "CFC closed-loop" (P300, setting "1").

0 = **Voltage controlled**: With the first start of the machine, a voltage indicator is memorised which ensures that the rotor of the machine is set to the rotor position "zero". This type of starting position of the rotor can only be used if there is no counter-torque from the machine (e.g. flywheel drive) at frequency "zero". If this condition is fulfilled, this method of determining the position of the rotor is very precise (<1° electrical). In principle, this method is not suitable for lifting equipment, as there is always a counter-torque.

For operation without encoders, the following applies: Up to the switch over frequency P331 the motor (with the nominal current memorised) is driven under voltage control. Once the switch over frequency has been reached, the method of determining the rotor position is switched over to the EMF method. If, taking hysteresis (P332) into account, the frequency falls below the value in (P331), the frequency inverter switches back from the EMF method to voltage controlled operation.

1 = **Test signal method**: The starting position of the rotor is determined with a test signal. This method also functions at a standstill with the brake applied, however it requires a PMSM with sufficient anisotropy between the inductivity of the d and q axes. The higher this anisotropy is, the greater the precision of the method. By means of parameter (P212) the voltage level of the test signal can be adjusted and with parameter (P213) the position of the motor position control can be adjusted. For motors which are suitable for use with the test signal method, a rotor position accuracy of 5°…10° electrical can be achieved (depending on the motor and the anisotropy).

2 = **Value from universal encoder,** "*Value from universal encoder"*: With this method the starting position of the rotor is determined from the absolute position of a universal encoder (Hiperface, EnDat with Sin/Cos track, BISS with Sin/Cos track or SSI with Sin/Cos track) The universal encoder type is set in parameter (P604).

For this position information to be unique it must be known (or determined) how this rotor position relates to the absolute position of the universal encoder. This is performed via the offset parameter (P334). Motors should be delivered either with a starting rotor position "zero" or the starting rotor position must be marked on the motor.If this value is not available, the offset value can also be determined with the settings "0" and"1" of parameter (P330). For this the drive unit is started with the setting "0" or "1". After the first start the offset value which has been determined is saved in parameter (P334).However, this value is volatile, i.e. it is only saved in the RAM. In order to save it in the EEPROM, it must be briefly changed and then set back to the determined value.

After this, fine tuning can be carried out with the motor idling. For this, the drive is operated in closed loop mode (P300=1) at as high a speed as possible below the field weakening point. From the starting point, the offset is gradually adjusted so that the value of the voltage component U_d (P723) is as close to zero as possible. For this, a balance between the positive and negative direction of rotation must be sought.

Usually the value "zero" will not be completely achieved, as at higher speeds the drive is subjected to a slight load due to the motor fan. The universal encoder should be located on the motor shaft.

3 = **Value from CANopen encoder,** *"Value from CANopen encoder"*: As for "2", however a CANopen absolute encoder is used to determine the starting position of the rotor.

4 = **Voltage control sync:** *"Voltage control, synchronous"*: Same as "0", but the synchronisation takes place after each enable.

5 = **Testsignal sync.:** *"Test signal, synchronous"*: Same as "1", but the synchronisation takes place after each enable.

6 = **Value CANopen.sync:** *"Value of CANopen encoder, synchronous"*: Same as "3", but the synchronisation takes place after each enable.

7 = **Value univ.enc.Sync:** *"Value of universal encoder, synchronous"*: Same as "2", but the synchronisation takes place after each enable.

NOTE: If there is an incremental encoder with a "null track" on the motor shaft, the "null track" can also be used to determine the position of the stator. The zero impulse is then used for synchronisation of the rotor position.

The offset between the zero pulse and the actual "zero" rotor position is set in parameter (P334) "Encoder offset". If the Sense cable (+5V Sense and 0V Sense) is not connected, there is no synchronisation to the zero pulse. Parameter (P330) must be set to "0" or "1". The value which needs to be set for parameter (P334) must be determined experimentally or must be enclosed with the motor.

P331	**Switch over freq. CFC ol** *(Switch over frequency CFC open-loop)* (Former designation: "**Switch over freq. PMSM**")		**S**	**P**
5.0 ... 100.0 % { 15.0 }	Definition of the frequency from which, in operation without encoder, the control method of a PMSM (Permanent Magnet Synchronous Motor) is activated according to (P300). In this case, 100 % corresponds to the nominal motor frequency from (P201). The parameter is only relevant for the control method "CFC open-loop" (P300, setting "2").			

P332	**Hyst. Switchover CFC ol** *(Switchover frequency hysteresis CFC open-loop)* (Former designation: "**Hyst. Switchover PMSM**")		**S**	**P**
0.1 ... 25.0 % { 5.0 }	Difference between the switch-on and switch-off point in order to prevent oscillation on the transition of operation without encoder into the control method specified in (P330) (and vice versa).			

P333	Flux feedback CFC ol *(Flux feedback CFC open-loop)* (Former designation: "**Flux feedb. fact. PMSM**")		S	P

5 ... 400 %
{ 25 }

This parameter is necessary for the position monitor in CFC open-loop mode. The higher the value which is selected, the lower the slip error from the rotor position monitor. However, higher values also limit the lower limit frequency of the position monitor. The larger the feedback amplification which is selected, the higher the limit frequency and the higher the values which must be set in (P331) and (P332). This conflict of objectives can therefore not be resolved simultaneously for both optimisation objectives.

The default value is selected so that it typically does not need to be adjusted for NORD IE4 motors.

P334	Encoder offset PMSM *(Encoder offset PMSM)*		S	

-0.500 ... 0.500 rev
{ 0000 }

Evaluation of the zero track is necessary for operation of PMSM (Permanent Magnet Synchronous Motors). The zero pulse is then used for synchronisation of the rotor position.

The value to be set for parameter **P334** (offset between zero pulse and actual rotor position “zero”) must be determined experimentally or included with the motor.

Motors supplied by NORD typically have a sticker attached to them, which specifies the setting value.

Provided that the specifications on the motor are specified in °, these must be converted into rev (for example 90° = 0.250 rev).

P335	Sync. zero pulse encoder *(Synchronisation of zero track of the incremental encoder)*			

0 ... 3
{ 0 }

The zero track of an incremental encoder can only be evaluated if the universal encoder interface (X14) is not occupied by a universal encoder.

The zero track can be used either to synchronise the zero position of the PMSM rotor or the zero point (reference point) of an incremental encoder.

0 =	**Sync. switched off**	→ Synchronisation switched off
1 =	**Sync. PMSM rotor position**	→ Synchronisation of the rotor position of a PMSM
2 =	**Sync. reference pos.**	→ Synchronisation of the reference point (POSICON)
3 =	**Sync. PMSM+Pos.**	→ Synchronisation of the reference point (POSICON) and the rotor position of a PMSM

P336	Rotor pos. identification mode *(Rotor position identification mode)*		S	

0 ... 2
{ 0 }

The precise position of the rotor must be known in order to operate a PMSM. This can be determined by various methods.

0 = First enabling	Identification of the PMSM rotor position is performed when the drive is enabled for the first time.
1 = Supply voltage	Identification of the PMSM rotor position is performed when the supply voltage is applied for the first time.
2 = Digital input/Bus input bit	Identification of the PMSM rotor position is triggered with an external order by means of a binary bit (digital input (P420) or Bus-in bit (P480), setting "79", "rotor position identification").

NOTE:

Identification of the rotor position is only performed if the FI is in the “ready for switch-on” state and the rotor position is not known (see P434, P481 function 28).

Use of the parameter is only advisable if the test signal method is set (P330).

P351	**PLC Setpoint selection** *(PLC Setpoint selection)*		**S**	
0 ... 3 { 0 }	Selection of the source for the control word (STW) and the main setpoint (HSW) with active PLC functionality (P350 = 1). With the settings "0" and "1", the main setpoints are defined via (P553), but the definition of the auxiliary setpoints remains unchanged via (P546). This parameter is only taken over if the frequency inverter is in "Ready to start" status. **0 =** **STW & HSW = PLC:** The PLC supplies the control word (STW) and the main setpoint (HSW), and parameters (P509) and (P510[-01]) have no effect. **1 =** **STW = P509:** The PLC supplies the main setpoint (HSW), the control word (STW) corresponds to the setting in parameter (P509) **2 =** **HSW = P510[1]:** The PLC supplies the control word (STW), the source for the main setpoint (HSW) corresponds to the setting in parameter (P510[-01]) **3 =** **STW & HSW = P509/510:** The source for the control word (STW) and the main setpoint (HSW) corresponds to the setting in parameter (P509)/(P510[-01])			

P353	**Bus status via PLC** *(Bus status via PLC)*		**S**	
0 ... 3 { 0 }	This parameter can be used to determine how the control word (STW) for the master function and the status word (ZSW) of the frequency inverter undergo further processing by the PLC. **0 =** **Off:** The control word (STW) of the master function (P503≠0) and the status word (ZSW) undergo further processing by the PLC without change. **1 =** **STW for broadcast:** The control word (STW) for the master value function (P503≠ 0) is set by the PLC. In order to do this, the control word must be redefined in the PLC using process value "34_PLC_Busmaster_Control_word". **2 =** **ZSW for bus:** The status word (ZSW) of the frequency inverter is set by the PLC. In order to do this, the status word must be redefined in the PLC using process value "28_PLC_status_word". **3 =** **STW Broadcast&ZSWBus:** *See setting 1 and 2*			

P355 **[-01]** **...** **[-10]**	**PLC Integer Setpoint** *(PLC Integer Setpoint)*		**S**	
0x0000 … 0xFFFF all = { 0 }	Data can be exchanged with the PLC via this INT array. This data can be used by the appropriate process variables in the PLC.			

P356 **[-01]** **...** **[-05]**	**PLC Long Setpoint** *(PLC Long Setpoint)*		**S**	
0x0000 0000 … 0xFFFF FFFF all = { 0 }	Data can be exchanged with the PLC via this DINT array. This data can be used by the appropriate process variables in the PLC.			

P360 **[-01]** **...** **[-05]**	**PLC display value** *(PLC display value)*		**S**	
-2 000 000,000 … 2 000 000.000 all = { 0.000 }	The parameter is only used to display the PLC Date. Via the corresponding process variables, this parameter can be written by the PLC. The values are not saved!			

P370	PLC Status *(PLC Status)*		S	

0 … 63dec

ParameterBox:
0x00 … 0x3F

SimpleBox / ControlBox:
0x00 … 0x3F

all = { 0 }

Displays the actual status of the PLC.

Bit 0 = P350=1: Parameter P350 was set in the "Activate internal PLC" function

Bit 1 = PLC active: The internal PLC is active.

Bit 2 = Stop active: The PLC program is in "Stop" status.

Bit 3 = Debug active: The error checking of the PLC program runs.

Bit 4 = PLC error: The PLC has an error, but PLC user errors 23.xx are not displayed here.

Bit 5 = PLC halted: The PLC program has been halted (*Single Step* or *Breakpoint*).

5.1.5 Control terminals

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set
P400 **[-01]** **...** **[-08]**	**Digital analog input** *(Analog input function)*			**P**

0 ... 82
{ [-01] = 1 }
all other { 0 }

[-01] = Analog input 1: analog input 1, integrated into the FI

[-02] = Analog input 2: analog input 2, integrated into the FI

[-03] = External analog input 1, *"External analog input 1"*: Analog input 1 of the first IO extension

[-04] = External analog input 2, *"External analog input 2"*: Analog input 2 of the first IO extension

[-05] = External Analog input 1, 2nd IOE, *"External analog input 1 of the 2nd IOE"*: Analog input 1 of the second IO extension

[-06] = External Analog input 2, 2nd IOE, *"External analog input 2 of the 2nd IOE"*: Analog input 2 of the second IO extension

[-07] = Analog function, Dig2, *"Analog function of digital input 2"*: Analog function of digital input 2 integrated into the FI. With this setting, digital input DIN2 is set to evaluate pulse signals. The pulses are then evaluated as an analog signal according to the function which is set here.

[-08] = Analog function, Dig3, *"Analog function of digital input 3"*: Analog function of digital input 3 integrated into the FI. With this setting, digital input DIN3 is set to evaluate pulse signals. The pulses are then evaluated as an analog signal according to the function which is set here.

In addition to the internal analog inputs, analog functions from the digital inputs DIN 2 and DIN 3 or the analog inputs of optional IO extension modules can also be processed.

Assignment of the analog functions is carried out in the relevant array of parameter P400. The possible analog functions can be found in the following table.

Assignment of digital functions to the analog inputs 1 and 2 of the motor controller is carried out in parameter P420 [-08] or [-09]. The functions which can be set correspond to those of the digital inputs (see table after P420).

The possible functions are listed in the following tables.

List of possible analogue functions of the analogue inputs

Value	Function	Description
00	Off	The analogue input has no function. After the FI has been enabled via the control terminals, it supplies the set minimum frequency **(P104)**.
01	Set point frequency	Via the setting range defined in **P402 / P403**, the output frequency of the frequency inverter is varied between the set minimum and maximum frequency (**P104/P105**).
02	Torque current limit	Based on the set torque current limit (**P112**), this can be changed by means of an analogue value. Here, 100% setpoint corresponds to the set torque current limit **P112**.

Value	Function	Description
03	PID current freq. [1]	Needed to set up a control loop. The analogue input (actual value) is compared with the setpoint (e.g. fixed frequency). The output frequency is adjusted as far as possible until the actual value equals the setpoint (see control values **P413 ... P415**).
04	Frequency addition [2]	The supplied frequency value is added to the setpoint.
05	Frequency subtract. [2]	The supplied frequency value is subtracted from the setpoint.
06	Current limit	Based on the set current limit (**P536**), this can be changed via the analogue input.
07	Maximum frequency	The maximum frequency of the FI is varied. 100% corresponds to the setting in parameter **P411**. 0% corresponds to the setting in parameter **P410**. The values for the min./max. output frequency (**P104/P105**) cannot be undershot/exceeded.
08	PID ltd.current.freq [1]	Same as function {3} "*PID current freq.*", but the output frequency cannot drop below the programmed "Minimum frequency" value in parameter **P104** (no phase sequence reversal).
09	PID suprvsd.cur.freq [1]	Same as function {3} *"PID current freq."*, but the FI switches off the output frequency when the minimum frequency **P104** is reached.
10	Servo-Mode Torque	In servo mode ((**P300**) = "1"), the motor torque can be set/limited via this function. Here, the speed controller is switched off and a torque control is activated. In this case, the analogue input is the setpoint source. With firmware version SW 2.0 and higher, this function can be used without servo mode or with ((**P300**) = "0"), but with reduced control precision.
11	Pre-tension Torque	Function, which enables a value for the torque requirement to be entered in the controller beforehand (disturbance variable feedforward). This function can be used to improve the load take-up of lifting gears with separate load measuring.
12	Reserved	
13	Multiplication	The setpoint is multiplied by the supplied analogue value. Here, the analogue value adjusted to 100% corresponds to a multiplication factor of 1.
14	Cur.val process ctrl [1]	activates the process controller. The analogue input 1 is connected to the actual value encoder (compensator, pressurised can, flow volume meter, etc.). The mode (0-10 V or 0/4-20 mA) is set in **P401**.
15	Nom.val process ctrl [1]	Same as function {14}, but the setpoint is specified (e.g. by a potentiometer). The actual value must be specified using another input.
16	Add. process control [1]	Adds an adjustable additional setpoint after the process controller.
46	Setval.torque p.reg.	Setpoint Torque Process controller
48	Motor temperature	Motor temperature measurement with KTY-84, details in Chapter 4.4
53	d-corr. F Process	"Diameter correction, PID process control frequency"
54	d-corr. Torque	"Diameter correction, torque"
55	d-corr. F+Torque	"Diameter correction, PID process control frequency, and torque"

1) Process controller details: P400 and 8.2 "Process controller".

2) The limits of these values are created from the >Min. freq. a-in 1/2< P410 parameter and the >Max. freq. a-in 1/2< P411 parameter.

More analogue functions

NOTE: Overview of scaling (see chapter 8.9 "Scaling of setpoint/actual values

").

List of possible digital functions of the analog inputs

The analog inputs of the FI can also be parameterised to process digital signals. The digital functions are set in parameter P420 [-08] or [-09].

If a digital function is assigned to an analog input, the analog function of the relevant input must be set to {0} "Off" in order to prevent misinterpretation of the signals.

A detailed description of the digital functions can be found after parameter P420. The functions of the digital inputs are identical to the digital functions of the analog inputs.

Permissible voltage when using digital functions: 7.5...30 V.

NOTE:

The analog inputs with digital functions do not comply with EN61131-2 (Type 1 digital inputs), because the idling currents are too low.

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set
P401 **[-01] ... [-06]**	**Analog input mode** *(Mode analog input)*			

0 ... 5
{ all 0 }

This parameter determines how the frequency inverter reacts to an analog signal which is less than the 0% adjustment (P402).

[-01] = Analog input 1: analog input 1, integrated into the FI

[-02] = Analog input 2: analog input 2, integrated into the FI

[-03] = External analog input 1, *"External analog input 1"*: Analog input 1 of the first IO extension

[-04] = External analog input 2, *"External analog input 2"*: Analog input 2 of the first IO extension

[-05] = External Analog input 1, 2nd IOE, *"External analog input 1 of the 2nd IOE"*: Analog input 1 of the second IO extension

[-06] = External Analog input 2, 2nd IOE, *"External analog input 2 of the 2nd IOE"*: Analog input 2 of the second IO extension

0 = 0 – 10V limited: An analogue setpoint smaller than the programmed adjustment 0% (P402) does not lead to undershooting of the programmed minimum frequency (P104), i.e. it does not result in a change of the direction of rotation.

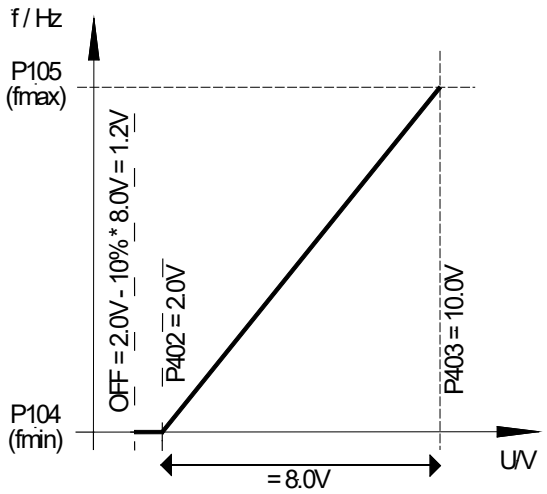
1 = 0 – 10V: If a setpoint smaller than the programmed adjustment 0% (P402) is present, this can cause a change in direction rotation. This allows rotation direction reversal using a simple voltage source and potentiometer.

E.g. internal setpoint with rotation direction change: P402 = 5 V, P104 = 0 Hz, Potentiometer 0-10 V → Rotation direction change at 5 V in mid-range setting of the potentiometer.

At the moment of reversal (hysteresis = ± P505), the drive stands still when the minimum frequency (P104) is smaller than the absolute minimum frequency (P505). A brake that is controlled by the FI will have entered the hysteresis range.

If the minimum frequency (P104) is greater than the absolute minimum frequency (P505), the drive reverses when the minimum frequency is reached. In the hysteresis range ± P104, the FI supplies the minimum frequency (P104), the brake controlled by the FI is not applied.

2 = 0 – 10V monitored: If the minimum adjusted setpoint (P402) is undershot by 10% of the difference value from P403 and P402, the FI output switches off. Once the setpoint is greater than [P402 - (10% * (P403 - P402))], it will deliver an output signal again. With the change to firmware version V 2.2 R0 the behaviour of the FI changes in that the function is only active if a function for the relevant input has been selected in P400



E.g. setpoint 4-20 mA: P402: Adjustment 0 % = 1 V; P403: Adjustment 100 % = 5 V; -10 % corresponds to -0.4 V; i.e. 1...5 V (4...20 mA) normal operating zone, 0.6...1 V = minimum frequency setpoint, below 0.6 V (2.4 mA) output switches off.

3 = - 10V – 10V: If a setpoint smaller than the programmed adjustment 0% (P402) is present, this can cause a change in direction rotation. This allows rotation direction reversal using a simple voltage source and potentiometer.

E.g. internal setpoint with rotation direction change: P402 = 5 V, P104 = 0 Hz, Potentiometer 0-10 V → Rotation direction change at 5 V in mid-range setting of the potentiometer.

At the moment of reversal (hysteresis = ± P505), the drive stands still when the minimum frequency (P104) is smaller than the absolute minimum frequency (P505). A brake that is controlled by the FI will not have entered the hysteresis range.

If the minimum frequency (P104) is greater than the absolute minimum frequency (P505), the drive reverses when the minimum frequency is reached. In the hysteresis range ± P104, the FI supplies the minimum frequency (P104), the brake controlled by the FI is not applied.

NOTE: The function -10 V – 10 V is a description of the method of function and not a reference to a bipolar signal (see example above).

4 = 0 – 10V with Error 1, *"0 – 10V with shut-down on Error 1"*:
If the value of the 0% adjustment in (P402) is undershot, the error message 12.8 "Undershoot of Analogue In Min." is activated.
If the value of the 100% adjustment in (P402) is undershot, the error message 12.9 "Undershoot of Analogue In Max." is activated.
Even if the analogue value is outside the limits defined in (P402) and (P403), the setpoint value is limited to 0 - 100%.

The monitoring function only becomes active if an enable signal is present and the analogue value has reached the valid range (≥(P402) or ≤(P403)) for the first time (e.g. pressure build-up after switching on a pump).
Once the function has been activated, it also operates if the actuation takes place via a field bus, for example, and the analogue input is not actuated at all.

5 = 0 – 10V m with Error 2 , *"0 – 10V with switch-off on Error 2"*:
See setting 4 ("0 - 10V with error switch off 1"), however:

In this setting the monitoring function only becomes active if an enable signal is present and the time during which the error monitoring is suppressed has elapsed. This suppression time is set in parameter (P216).

P402	**[-01] ... [-06]**	**Adjustment: 0%** *(Analog input adjustment: 0%)*		**S**	

-50.00 ... 50.00 V
{ all 0.00 }

This parameter sets the voltage that should correspond with the minimum value of the selected function for the analog input.

[-01] = Analog input 1: analog input 1, integrated into the FI

[-02] = Analog input 2: analog input 2, integrated into the FI

[-03] = External analog input 1, *"External analog input 1"*: Analog input 1 of the first IO extension

[-04] = External analog input 2, *"External analog input 2"*: Analog input 2 of the first IO extension

[-05] = External Analog input 1, 2nd IOE, *"External analog input 1 of the 2nd IOE"*: Analog input 1 of the second IO extension

[-06] = External Analog input 2, 2nd IOE, *"External analog input 2 of the 2nd IOE"*: Analog input 2 of the second IO extension

Typical setpoints and corresponding settings:

0 – 10 V	→	0.00 V
2 – 10 V	→	2.00 V (monitored for function 0-10 V)
0 – 20 mA	→	0.00 V (internal resistance approx. 250 Ω)
4 – 20 mA	→	1.00 V (internal resistance approx. 250 Ω)

P403	[-01] ... [-06]	**Adjustment: 100%** *(Analog input adjustment: 100%)*		S	

-50.00 ... 50.00 V
{ all 0.00 }

This parameter sets the voltage that should correspond with the maximum value of the selected function for the analog input.

[-01] = Analog input 1: analog input 1, integrated into the FI

[-02] = Analog input 2: analog input 2, integrated into the FI

[-03] = External analog input 1, *"External analog input 1"*: Analog input 1 of the first IO extension

[-04] = External analog input 2, *"External analog input 2"*: Analog input 2 of the first IO extension

[-05] = External Analog input 1, 2nd IOE, *"External analog input 1 of the 2nd IOE"*: Analog input 1 of the second IO extension

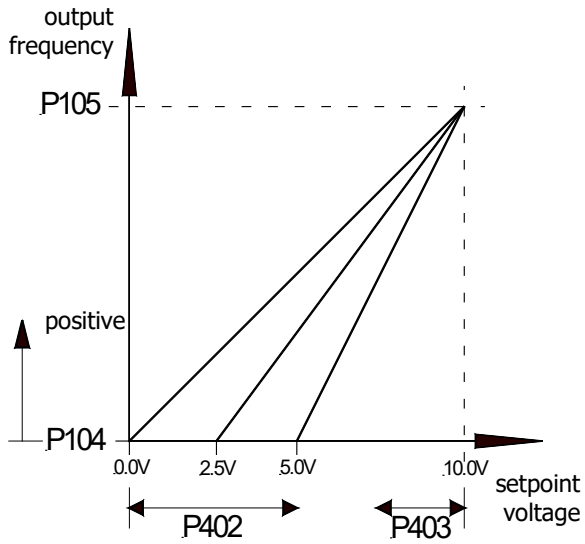
[-06] = External Analog input 2, 2nd IOE, *"External analog input 2 of the 2nd IOE"*: Analog input 2 of the second IO extension

Typical setpoints and corresponding settings:

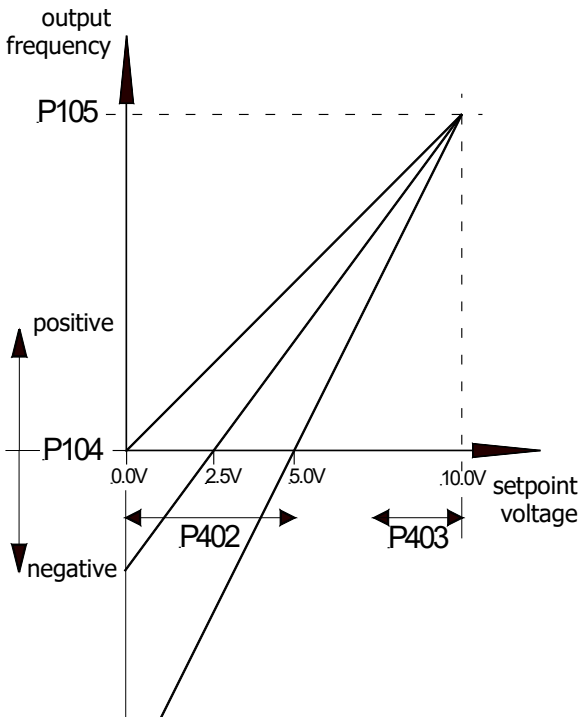
0 – 10 V	→	10.00 V
2 – 10 V	→	10.00 V (monitored for function 0-10 V)
0 – 20 mA	→	5.00 V (internal resistance approx. 250 Ω)
4 – 20 mA	→	5.00 V (internal resistance approx. 250 Ω)

P400 ... P403

P401 = 0 → 0 - 10V limited



P401 = 1 → 0 - 10V not limited



P404	[-01] [-02]	**Analogue input filter** *(analogue input filter)*		S	

1 ... 400 ms
{ all 100 }

Adjustable digital low-pass filter for the analogue signal. Interference peaks are hidden, the reaction time is extended.

[-01] = Analogue input 1: analogue input 1 integrated in the device
[-02] = Analogue input 2: analogue input 2 integrated in the device

The filter time for the analogue inputs of the optional external IO extension modules is set in the parameter set for the relevant module (P161).

P410	**Min. freq. a-in 1/2** *(Minimum frequency a-in 1/2 (auxiliary setpoint value))*			P

-400.0 ... 400.0 Hz
{ 0.0 }

The minimum frequency that can act on the setpoint via the auxiliary setpoints.
Auxiliary setpoints are all frequencies that are additionally delivered for further functions in the FI:

Actual frequency PID | Frequency addition | Frequency subtraction
Auxiliary setpoints via BUS | Process controller
Min. frequency above analog setpoint (potentiometer)

P411	**Max. freq. a-in 1/2** *(Maximum frequency a-in 1/2 (auxiliary setpoint value))*			P

-400.0 ... 400.0 Hz
{ 50.0 }

The maximum frequency that can act on the setpoint via the auxiliary setpoints.
Auxiliary setpoints are all frequencies that are additionally delivered for further functions in the FI:

Actual frequency PID | Frequency addition | Frequency subtraction
Auxiliary setpoints via BUS | Process controller
Min. frequency above analog setpoint (potentiometer)

P412	**Nom. val. process ctrl.** *(Nominal value process controller)*		S	P

-10.0 ... 10.0 V
{ 5.0 }

Fixed specification of a setpoint for the process controller that will only occasionally be altered.
Only with P400 = 14 ... 16 (process controller) (see chapter 8.2 "Process controller").

P413	**PID control P comp.** *(P-component of PID controller)*		S	P

0.0 ... 400.0 %
{ 10.0 }

This parameter is only effective when the function PID actual frequency is selected.
The P-component of the PID controller determines the frequency jump if there is a control deviation based on the control difference.
E.g.: At a setting of P413 = 10% and a rule difference of 50%, 5% is added to the actual setpoint.

P414	**PID control I comp.** *(I-component of PID controller)*		S	P

0.0 ... 3,000.0 %/s
{ 10.0 }

This parameter is only effective when the function PID actual frequency is selected.
The I-component of the PID controller determines the frequency change, dependent on time.
Up to SW 1.5 the setting range was 0.00 to 300.00 ‰/ms! This can cause incompatibilities in the transfer of data sets between FIs with different software versions.

P415	PID control D comp. *(D-component of PID controller)*		S	P

0 ... 400.0 %ms
{ 1.0 }

This parameter is only effective when the **function PID actual frequency** is selected.

If there is a rule deviation, the D-component of the PID controller determines the frequency change multiplied by time (%ms).

If one of the analog inputs is set in the **function actual value process controller**, this parameter determines the controller limitation (%) after the PI controller. For further details, see Section 8.2.

P416	Ramp time PI setpoint *(Ramp time PI setpoint value)*		S	P

0.00 ... 99.99s
{ 2.00 }

This parameter is only effective when the function PID actual frequency is selected.

Ramp for PI setpoint

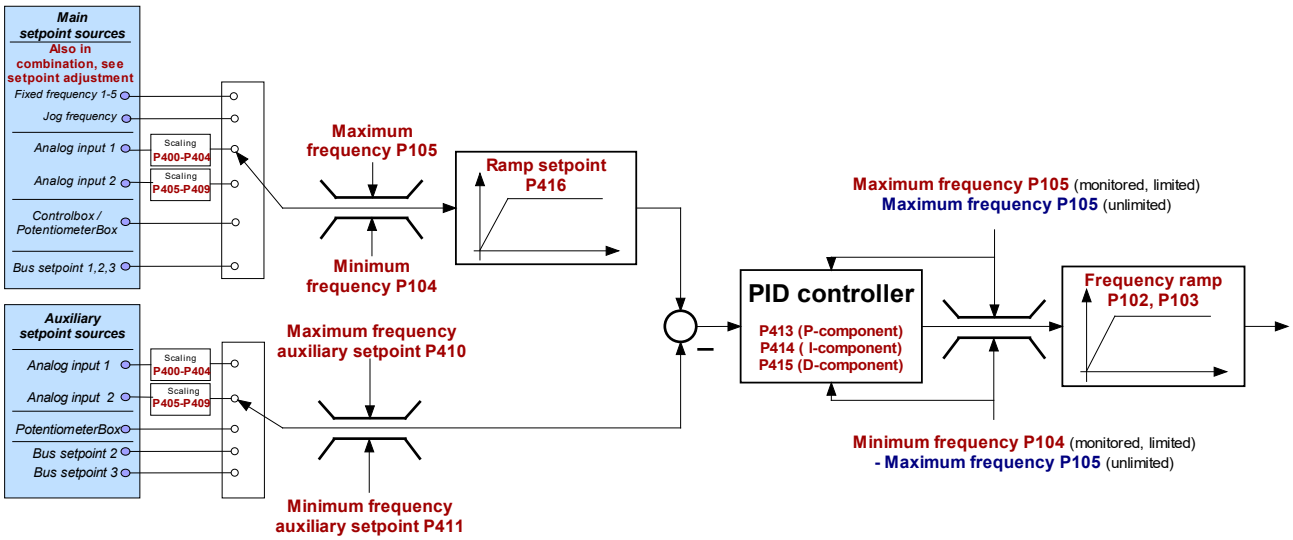


Fig.: Flow diagram for PID controller

P417	[-01] ... [-03]	Analog output offset *(Analog output offset)*		S	P

-10.0 ... 10.0 V
{ all 0.0 }

[-01] = Analog output: analog output integrated into the FI

[-02] = First IOE, *"External analog output of first IOE"*: Analog output 1 of the first IO extension

[-03] = Second IOE, *"External analog output of second IOE"*: Analog output 1 of the second IO extension

In the analog output function an offset can be entered to simplify the processing of the analog signal in other equipment.

If the analog output has been programmed with a digital function, then the difference between the switch-on point and the switch-off point can be set in this parameter (hysteresis).

P418	[-01] ... [-03]	Function analog output *(Analog output function)*			P

0 ... 60
{ all 0 }

[-01] = Analog output: analog output integrated into the FI

[-02] = First IOE, *"External analog output of first IOE"*: Analog output 1 of the first IO extension

[-03] = Second IOE, *"External analog output of second IOE"*: Analog output 1 of the second IO extension

Analog functions (max. load: 5 mA analog, 20 mA digital)**:**

An analog (0 ... +10V) voltage can be obtained from the control terminals (max. 5 mA). Various functions are available, whereby:

0 Volt analog voltage always corresponds to 0 % of the selected value.

10 V always corresponds to the motor nominal values (unless otherwise stated) multiplied by the P419 standardisation factor, e.g.:

$$\Rightarrow 10\text{Volt} = \frac{\text{nominal motor value} \cdot \text{P419}}{100\%}$$

The possible functions are listed in the following tables.

NOTE: *Use of module SK CU4-IOE2*: The function of the first analogue output is set as usual via Array [-02]. The function of the 2nd analogue output is set via the array [-03].

Therefore, with the use of an IO extension of this type, only one IO extension can be evaluated by the frequency inverter.

List of possible analog functions of the analog outputs

Value	Function	Description
00	No function	No output signal at terminals.
01	Actual frequency	The analog voltage is proportional to the output frequency of the device
02	Actual speed	Is the synchronous speed calculated by the device, based on the present setpoint value. Load-dependent speed fluctuations are not taken into account. If Servo mode is being used, the measured speed will be output via this function.
03	Current	Is the effective value of the output current delivered by the device.
04	Torque current	Indicates the motor load torque calculated by the device. (100 % = P112)
05	Voltage	Is the output voltage delivered by the device.
06	DC link voltage	Is the DC voltage in the device. This is not based on the motor rated data. 10 V Volt, standardised at 100 %, is equivalent to 450V DC (230 V mains) or 850 Volt DC (480 V mains)!
07	Value of P542	The analog output can be set with parameter P542, regardless of the actual operating status of the device. With bus control, e.g. an analog value from the control unit can be tunnelled directly to the analog output of the FI.
08	Apparent power	The actual apparent power of the motor as calculated by the device
09	Effective power	The actual effective power calculated by the device
10	Torque [%]	The actual torque calculated by the device
11	Field [%]	The actual field in the motor, as calculated by the device
12	Actual frequency ±	The analog voltage is proportional to the output frequency of the device, whereby the null point is shifted to 5 V. For rotation to the right, values between 5 V and 10 V are output, and for rotation to the left values between 5 V and 0 V.
13	Actual speed ±	This is the synchronous rotation speed calculated by the FI, based on the current setpoint, where the null point has been shifted to 5 V. For rotation to the right, values from 5 V to 10 V are output and for rotation to the left, values from 5 V to 0 V. The measured speed is output via this function if servo mode is used.
14	Torque [%] ±	Is the actual torque calculated by the FI, whereby the null point is shifted to 5 V. For drive torques, values between 5 V and 10 V are output, and for generator torque, values between 5 V and 0 V.
30	Setpoint freq. before ramp	displays the frequency produced by any upstream controllers (ISD, PID, etc.). This is then the setpoint frequency for the power stage after it has been adjusted by the acceleration or braking ramp (P102, P103).

Value	Function	Description
31	Output via BUS PZD	the analog output is controlled via a bus system. The process data is directly transferred (P546, P547, P548 = 20).
33	Freq. of setpt. source,	"Frequency of setpoint source" (above SW version 1.6)
60	*Reserved*	*(above SK540E → BU 0550)*

NOTE: overview of various setpoints: (see chapter 8.9 "Scaling of setpoint/actual values ").

List of possible digital functions of the analogue outputs

All relay functions described in parameter P434 can also be transferred via the analogue output. If a condition has been fulfilled, 10 V will be applied at the output terminals. A negation of a function can be specified in parameter P419.

Value	Function	Value	Function
15	External brake	**32**	Inverter ready
16	Inverter is working	**34**	... 40 Reserved (POSICON → BU 0510)
17	Current limit	**41**	... 43 Reserved
18	Torque current limit	**44**	BusIO In Bit 0
19	Frequency limit	**45**	BusIO In Bit 1
20	Level with setpoint	**46**	BusIO In Bit 2
21	Fault	**47**	BusIO In Bit 3
22	Warning	**48**	BusIO In Bit 4
23	Overcurrent warning	**49**	BusIO In Bit 5
24	Mot.overtemp.warning	**50**	BusIO In Bit 6
25	Torque current limit	**51**	BusIO In Bit 7
26	Value of P541	**52**	Value Bus Setpoint Output via bus (if P546, P547 or P548 = 19); BUS bit 4 controls the analogue output.
27	Torq.curr. limit gen		
28	... 29 Reserved		

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set
P419 **[-01] ... [-03]**	**Scaling of analog output** *(Scaling of analog output)*			**P**

-500 ... 500 %
{ all 100 }

[-01] = Analog output: analog output integrated into the FI
[-02] = First IOE, *"External analog output of first IOE"*: Analog output 1 of the first IO extension
[-03] = Second IOE, *"External analog output of second IOE"*: Analog output 1 of the second IO extension

Analog functions P418 (= 0 ... 6 and 8 … 14, 30)

With this parameter an adjustment can be made to the analog output for the selected working range. The maximum analog output (10 V) corresponds to the scaling value of the appropriate selection.

Therefore, if this parameter is raised from 100 % to 200 % at a constant working point, the analog output voltage is halved. The 10 Volt output signal then corresponds to twice the nominal value.

For negative values the logic is reversed. An actual value of 0 % will then produce 10 V at the output and -100 % will produce 0 V.

Digital functions P418 (= 15 ... 28, 34...52)

The switching threshold can be set using this parameter for the functions Current limit (= 17), Torque current limit (= 18) and Frequency limit (= 19). A value of 100 % refers to the corresponding motor nominal value (see also P435).

With a negative value, the output function is output negated (0/1 → 1/0).

P420 **[-01] ... [-10]**	**Digital inputs** *(digital input functions)*			

0 ... 80
{ [-01] = 1 }
{ [-02] = 2 }
{ [-03] = 8 }
{ [-04] = 4 }
all other { 0 }

Up to 10 inputs which can be freely programmed with digital functions are available. Of these inputs, analog inputs 1 and 2 of the frequency inverter do not comply with EN61131-2 (Type 1 digital inputs).

[-01] = Digital input 1 (DIN1): **Enable right**, (default), terminal 21
[-02] = Digital input 2 (DIN2): **Enable left**, (default), terminal 22
[-03] = Digital input 3 (DIN3): **Parameter switchover**, (default), terminal 23
[-04] = Digital input 4 (DIN4): **Fixed frequency 1** (P429), (default), terminal 24
[-05] = Digital input 5 (DIN5): **no function**, (default), terminal 25[1]
[-06] = Digital input 6 (DIN6): **no function**, (default), terminal 26
[-07] = Digital input 7 (DIN7): **no function**, (default), terminal 27[2]
[-08] = Digital function analog 1 (AIN1), "Digital function of analog input 1": terminal 14[3]
[-09] = Digital function analog 2 (AIN2), "Digital function of analog input 2": Terminal 16[3]
[-10] = Digital input 8 (DIN8): **no function**, (default), terminal 7[2]

List of possible digital input functions

Value	Function	Description	Signal
00	No function	Input switched off.	---

[1] Up to and including Size 4, digital input 5 is not available. In place of this a potential-free isolated thermistor input is implemented, whose function cannot be disabled. If no thermistor is present the two terminals TF- and TF+ must be bridged. Parameterisation of this input does not have any effect.

[2] Digital input 7 (DIN7) can also be used as digital output 3 (DOUT3 / Binary output 5). It is recommended that either an input function (P420 [-07] or an output function (P434 [-05]) is parameterised. However, if an input function and an output function are parameterised, a High signal from the output function will result in the activation of the input function. This IO-exclusion is hence used as a kind of "flag". This also applies for digital input 8 (DIN8) and digital output 2 (DOUT2 / binary output 4).

[3] The analog inputs 1 and 2 (AIN1 / 2) can also process digital functions. Care must be taken that either an analog function (P400 [-01]/[-02]) or a digital function (P420 [-08]/[-09]) is parameterised in order to prevent misinterpretation of the signals.

Value	Function	Description	Signal
01	Enable right	The device delivers an output signal with the rotating field “right”, if a positive setpoint is applied. 0 → 1 edge (**P428 = 0**)	High
02	Enable left	The device delivers an output signal with the rotating field “left”, if a positive setpoint is applied. 0 → 1 edge (**P428 = 0**)	High
	If the drive is to start automatically when the mains voltage is switched on (**P428 = 1**), a permanent High level for enabling must be provided (bridge between DIN 1 and the control voltage output). If the functions “Enable right” and “Enable left” are actuated simultaneously, the device is blocked. If the controller is in fault status but the cause of the fault is no longer present, the error message is acknowledged with a 1 → 0 edge.		
03	Phase seq. reversal	Causes the rotating field to change direction (in combination with “Enable right” or “Enable left”).	High
04	Fixed frequency 1 [1]	The frequency from **P429** is added to the actual setpoint.	High
05	Fixed frequency 2 [1]	The frequency from **P430** is added to the actual setpoint.	High
06	Fixed frequency 3 [1]	The frequency from **P431** is added to the actual setpoint.	High
07	Fixed frequency 4 [1]	The frequency from **P432** is added to the actual setpoint.	High
	If several fixed frequencies are controlled simultaneously, they are added with the correct sign. In addition, the analogue setpoint (P400) and, if necessary, the minimum frequency (**P104**) are added.		
08	Param. set switching	First bit of the parameter set switching; selection of the active parameter set 1 … 4 [5)].	High
09	Maintain the freq.	During the acceleration or deceleration phase, a Low level will cause the actual output frequency to be “Maintained”. A High level allows the ramp to continue.	Low
10	Voltage disable [2]	The frequency inverter output voltage is switched off; the motor runs down freely.	Low
11	Quick stop [2]	The device reduces the frequency according to the quick stop time from P426.	Low
12	Fault acknowledgem. [2]	Fault acknowledgement with an external signal. If this function is not programmed, a fault can also be acknowledged by a Low enable setting (P506).	0→1 edge
13	PTC resistor input [2]	Analogue evaluation of the signal applied. Switching threshold approx. 2.5 V, switch-off delay = 2 s, warning after 1 s. NOTE: Function 13 can only be used via DIN 5 up to SK 535E, Sizes 1–4! For SK 54xE and sizes from Size 5, there is a separate connection, which cannot be deactivated. If the motor is not equipped with a PTC resistor, both terminals must be bridged for these devices in order to deactivate the function (delivery state).	Level
14	Remote control [2, 4]	With bus system control, Low level switches to control via control terminals.	High
15	Jog frequency [1]	The fixed frequency value can be adjusted using the HIGHER/LOWER and ENTER keys (**P113**), if control is via the ControlBox or ParameterBox.	High
16	Motor potentiometer	Same as setting value {09}, but the frequency is not maintained below the minimum frequency **P104** and above the maximum frequency P105.	Low
17	ParaSetSwitching 2	Second bit of the parameter set switching; selection of the active parameter set 1 … 4 [5)].	High
18	Watchdog [2]	The input must see a High edge cyclically (**P460**), otherwise error **E012** will cause a switch-off. Function starts with the 1st High edge.	0→1 edge
19	Setpoint 1 on / off	Analogue input switch-on and switch-off 1/2 (High = ON) The Low signal sets the analogue input to 0%, which does not lead to shutdown when the minimum frequency (**P104**) > absolute minimum frequency (**P505**).	High
20	Setpoint 2 on / off		
21	Fixed frequency 5 [1]	The frequency from **P433** is added to the actual setpoint.	High
22	... 25	*Reserved POSICON (BU 0510)*	
26	... 29 Pulse functions:	*Description below*	
30	Inhibit PID	Switching the PID control/process controller function on or off (High = ON)	High
31	Inhibit turn right [2,6]	Blocks the >Enable right/Enable left< via a digital input or bus control. Does not relate to the actual phase sequence of the motor (e.g. following negated setpoint).	Low
32	Inhibit turn left [2,6]		Low
33	... 42 Pulse functions:	*Description below (SK 500E … 535E only)*	
43	... 44 Speed measurement with HTL encoder	*Description below*	

Value	Function	Description	Signal
45	3-W-Ctrl.Start-Right (normally open switch)	3-wire control: This control function provides an alternative to "Enable right"/"Enable left" (01, 02), which requires permanently applied levels. In this case, only a control pulse is required to trigger the function. Control of the device can therefore be performed entirely with switches. A pulse on the function "Phase seq. reversal" (see function {65}) inverts the present phase sequence. This function is reset with a "Stop signal" or by activating a switch for the functions {45}, {46}, {49}.	0→1 edge
46	3-W-Ctrl.Start-Left (normally open switch)		0→1 edge
49	3-Wire-Ctrl.Stop (normally closed switch)		1→0 edge
47	Motorpot. Freq. +	In combination with "Enable right"/"Enable left", the output frequency can be continuously varied. To save a current value in **P113**, both inputs must be at a High voltage for 1.5 s. This value is then used as the next starting value for the same preselection of direction ("Enable right"/"Enable left"), otherwise start at f_{MIN}. Values from other setpoint sources (e.g. fixed frequencies) are not taken into account.	High
48	Motorpot. Freq. -		High
50	Bit0 fixedfreq.Array	Fixed-frequency array: Binary coded digital inputs to generate up to 32 fixed frequencies. (**P465: -01 ... -31**)	High
51	Bit1 fixedfreq.Array		High
52	Bit2 fixedfreq.Array		High
53	Bit3 fixedfreq.Array		High
54	Bit4 fixedfreq.Array		High
55	… 64	*Reserved POSICON (BU 0510)*	
65	3-Wire-Direction (phase sequence reversal switch)	See functions {45}, {46}, {49}	0→1 edge
66	… 69	*Reserved*	
70	Evacuation mode Software 1.7 and higher	For devices with external 24 V control voltage (SK 5x5E)) only. This provides the option of operation with a very low DC link voltage. With this function, the charging relay is energised, and the low-voltage and phase failure recognition is deactivated. NOTICE! No overload monitoring! (e.g. lifting gear)	High
71	Motorpot.F+ and Save [3] Software 1.6 and higher	Motor potentiometer function frequency +/- with automatic saving: With this motor potentiometer function (software 1.6 and higher), a setpoint (amount) is set and saved via the digital inputs. With control enabling R/L, this is then started up in the correspondingly enabled phase sequence. The frequency is retained on change of direction. Simultaneous activation of the +/- function causes the frequency setpoint to be set to zero.	High
72	Motorpot.F- and Save [3] Software 1.6 and higher	The frequency setpoint can also be displayed in the operating value display (**P001 = 30**, 'Cur. set value MP-S') or in **P718**, and can be pre-set in the "Ready to switch-on" operating mode. A set minimum frequency (**P104**) is still effective. Other setpoints, e.g. analogue or fixed frequencies, can be added or subtracted. The frequency setpoint adjustment is performed with the ramps from **P102/103**.	High
73	Inhibit right+quick [2,6]	Same as setting {31}, but coupled to the *"Quick stop"* function	Low
74	Inhibit left + quick [2,6]	Same as setting {32}, but coupled to the *"Quick stop"* function	Low
77		*Reserved POSICON (BU 0510)*	
79	Rotorpos. Ident	Precise knowledge of the rotor position is essential for PMSM operation. Rotor position identification is performed, if the following conditions are met: • The frequency inverter is in the status "Ready to switch-on". • The rotor position is not known (see **P434**, **P481**, function {28}). • Function {2} is selected in **P336**.	1→0 edge
80		*Reserved PLC (BU 0550)*	

Value	Function	Description	Signal

1) If none of the digital inputs is programmed to “Enable right” or “Enable left”, the control of a fixed frequency or jog frequency enables the frequency inverter. The rotating field direction depends on the sign of the setpoint.

2) Also effective for control via BUS (e.g. RS232, RS485, CANbus, CANopen, …)

3) With SK 5x5E devices, the frequency inverter’s control unit must be supplied with power for a further 5 minutes after the last change to the motor potentiometer in order to permanently save the data.

4) Function cannot be selected via BusIO In Bits

5) The operating parameter set is selected via correspondingly parametrised digital inputs or the BUS control. Switching can take place during operation (online). Coding is binary according to the following pattern. When enabled via the keyboard (SimpleBox, ControlBox, PotentiometerBox or ParameterBox), the operating parameter set will match the setting in **P100**.

Setting	Digital input Function [8]	Digital input Function [17]
0 = Parameter set 1	LOW	LOW
1 = Parameter set 2	HIGH	LOW
2 = Parameter set 3	LOW	HIGH
3 = Parameter set 4	HIGH	HIGH

6) Notice! When using this function for limit switch monitoring, it must be ensured that the limit switch cannot be overrun, because as soon as the limit switch has been left, the blocking of the phase sequence is automatically cancelled. The frequency inverter therefore accelerates again when the enable signal is applied.

HTL encoder function (only DIN2/4)

For the evaluation of an HTL encoder, the digital inputs DIN2 and DIN4 must be parameterised with the following functions.

Value	Function		Description	Signal
43	Track A HTL encoder	This function can only be used for digital inputs 2 (DIN2) and 4 (DIN4) !	A 24V HTL encoder can be connected to **DIN 2** and **DIN 4** in order to measure the speed. The maximum frequency at the DIN is limited to 10kHz. Accordingly, a suitable encoder (low pulse number) or suitable mounting (slow speed) SHOULD BE USED.	Impulse <10kHz
44	Track B HTL encoder		The direction of counting can be changed by exchanging the functions on the digital inputs. Further settings are in P461, P462, P463.	Impulse <10kHz

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set
P426	**Quick stop time** *(Quick stop time)*			**P**
0 ... 320.00 sec { 0.10 }	Setting of the stop time for the fast stop function which can be triggered either via a digital input, the bus control, the keyboard or automatically in case of a fault. Emergency stop time is the time for the linear frequency decrease from the set maximum frequency (P105) to 0Hz. If an actual setpoint <100% is being used, the emergency stop time is reduced correspondingly.			
P427	**Quick stop on error** *(Quick stop on error)*		**S**	
0 ... 3 { 0 }	Activation of automatic emergency stop following error **0 = OFF:** Automatic emergency stop following error is deactivated **1 = Mains supply failure:** Automatic emergency stop following mains supply failure **2 = In case of faults:** Automatic emergency stop following fault **3 = Fault or mains failure:** Automatic emergency stop in case of fault or mains failure An emergency stop can be triggered by the errors**E2.x, E7.0, E10.x, E12.8, E12.9** and **E19.0**.			

P428	**Automatic starting** *(Automatic starting)*		S	
0 ... 1 { 0 }	In default setting (P428 = **0 → Off**), the FI requires an edge to enable (signal change from "Low → High") on the relevant digital input. In the **On → 1** setting, the FI reacts to an applied High level. This function is only possible, if the FI is controlled via the digital inputs. (see P509 = 0/1) In some cases, the FI must start immediately when the mains voltage is switched on. For this purpose, P428 = **1 → An** can be set. If the enable signal is permanently switched on, or equipped with a cable jumper, the FI starts up immediately. **NOTE:** (P428) not "On", if (P506) = 6, **Danger!** (see note (P506))			

P429	**Fixed frequency 1** *(Fixed frequency 1)*			P
-400.0 ... 400.0 Hz { 0.0 }	Following actuation via a digital input and enabling of the FI (right or left), the fixed frequency is used as a setpoint. A negative setting value will cause a direction change (based on the *Enable rotation direction* P420 – P425, P470). If several fixed frequencies are actuated at the same time, then the individual values are added with the correct sign. This also applies to combinations with the jog frequency (P113), analog setpoint (if P400 = 1) or minimum frequency (P104). The frequency limits (P104 = f_{min}, P105 = f_{max}) cannot be over or undershot. If none of the digital inputs are programmed for enable (right or left), the simple fixed frequency signal results in an enable. A positive fixed frequency corresponds to a right enable, a negative to a left enable.			

P430	**Fixed frequency 2** *(Fixed frequency 2)*			P
-400.0 ... 400.0 Hz { 0.0 }	For a description of the function of the parameter, see **P429 >Fixed frequency 1<**			

P431	**Fixed frequency 3** *(Fixed frequency 3)*			P
-400.0 ... 400.0 Hz { 0.0 }	For a description of the function of the parameter, see **P429 >Fixed frequency 1<**			

P432	**Fixed frequency 4** *(Fixed frequency 4)*			P
-400.0 ... 400.0 Hz { 0.0 }	For a description of the function of the parameter, see **P429 >Fixed frequency 1<**			

P433	**Fixed frequency 5** *(Fixed frequency 5)*			P
-400.0 ... 400.0 Hz { 0.0 }	For a description of the function of the parameter, see **P429 >Fixed frequency 1<**			

P434	[-01] ... [-05]	Digital output function *(Digital output function)*			P

0 ... 40
{ [-01] = 1 }
{ [-02] = 7 }
all other { 0 }

Up to 5 outputs (2 of which are relays) are available. These can be freely programmed with digital functions. These can be seen in the following table.

[-01] = Binary output 1 / MFR1, *Relay output 1*: **external brake**, (default),	Terminal 1/2
[-02] = Binary output 2 / MFR2, *Relay output 2*: **Error**, (default),	Terminal 3/4
[-03] = Binary output 3 / DOUT1, *Digital output 1*: **no function**, (default),	Terminal 5
[-04] = Binary output 4 / DOUT2, *Digital output 2*: **no function**, (default),	Terminal 7 [1]
[-05] = Binary output 5 / DOUT3, *Digital output 3*: **no function**, (default),	Terminal 27 [1]

Outputs 1 and 2 (MFR1: Control terminals 1/2 and MFR2: Control terminals 3/4): The settings 3 to 5 and 11 act with a 10% hysteresis, i.e. the relay contact closes (Function 11 opens) when the limit value is reached and opens (function 11 closes) when a 10% smaller value is undershot. This behaviour can be inverted with a negative value in P435.

[1] Digital input 7 (DIN7) can also be used as digital output 3 (DOUT3 / Binary output 5). It is recommended that either an input function (P420 [-07] or an output function (P434 [-05]) is parameterised. However, if and input function and an output function are parameterised, a High signal from the output function will result in the activation of the input function. This IO connection is hence used as a kind of "flag". This also applies for digital input 8 (DIN8) and digital output 2 (DOUT2 / binary output 4).

List of the possible functions of relay and digital outputs

Value	Function	Description	Signal *
00	No function	Input switched off.	Low
01	External brake	For control of a mechanical brake on the motor. The relay switches at a programmed absolute minimum frequency (**P505**). For typical brakes, a setpoint delay of 0.2 ... 0.3 s (see also **P107**) should be programmed. A mechanical brake can be directly switched with AC. (Observe the technical specification of the relay contact!)	High
02	Inverter is working	The closed relay contact indicates voltage at the inverter output (U – V – W) (as well as DC run-on (→ **P559**)).	High
03	Current limit	Based on the nominal motor current setting in **P203**. This value can be adjusted via scaling (**P435**).	High
04	Torque current limit	Based on the motor data settings in **P203** and **P206**. Signals a corresponding torque load on the motor. This value can be adjusted via scaling (**P435**).	High
05	Frequency limit	Based on the nominal motor frequency setting in **P201**. This value can be adjusted via scaling (**P435**).	High
06	Level with setpoint	Indicates that the device has completed the frequency increase or decrease. Setpoint frequency = Actual frequency! From a difference of 1 Hz → Setpoint not reached – Contact opens.	High
07	Fault	General fault message, fault is active or not yet acknowledged. → Fault: Contact opens, ready for operation: Contact closes	Low
08	Warning	General warning. A limit value was reached, which could result in a later switch-off of the device.	Low
09	Overcurrent warning	At least 130% of the nominal device current was supplied for 30 seconds.	Low
10	Mot.overtemp.warning	Motor overtemperature (warning): The motor temperature is evaluated via the PTC resistor input or a digital input. → Motor is too hot. The warning is issued immediately; overtemperature switch-off after 2 seconds.	Low
11	Torque current limit	Torque current limit/current limit active (warning): The limit value in **P112** or **P536** has been reached. A negative value in **P435** inverts the behaviour. Hysteresis = 10%	Low
12	Value of P541	The output can be set using parameter **P541**, irrespective of the current operating status of the device.	High
13	Torq.curr. limit gen	Limit value in **P112** has been reached in the generator range. Hysteresis = 10%	Low
14		*… 17 Reserved*	- -
18	Inverter ready	The device is ready for operation. After being enabled, it delivers an output signal.	High
19		*… 27 Reserved POSICON (BU 0510)*	- -

Value	Function	Description	Signal *
28	Rotorpos PMSM ok	The PMSM rotor position is known.	High
29		*Reserved*	- -
30	BusIO In Bit 0	Control by Bus In Bit 0 (**P546 …**)	High
31	BusIO In Bit 1	Control by Bus In Bit 1 (**P546 …**)	High
32	BusIO In Bit 2	Control by Bus In Bit 2 (**P546 …**)	High
33	BusIO In Bit 3	Control by Bus In Bit 3 (**P546 …**)	High
34	BusIO In Bit 4	Control by Bus In Bit 4 (**P546 …**)	High
35	BusIO In Bit 5	Control by Bus In Bit 5 (**P546 …**)	High
36	BusIO In Bit 6	Control by Bus In Bit 6 (**P546 …**)	High
37	BusIO In Bit 7	Control by Bus In Bit 7 (**P546 …**)	High
38	Value Bus Setpoint	Value from bus setpoint (**P546 ...**)	High
	Details in the bus manuals		
39	STO inactive	The relay/bit drops, if STO or the safe stop is active.	High
40		*… Reserved PLC (BU 0550)*	

* For relay contacts (High = “Contact closed”, Low = “Contact open”)

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set
P435 **[-01] ... [-05]**	**Dig. out scaling** *(Scaling of digital output)*			**P**
-400 ... 400 % { all 100 }	Adjustment of the limiting values of the digital functions. For a negative value, the output function will be output negative.			
	[-01] = Output 1 / MFR1, *relay output 1*: **[-02] = Output 2 / MFR2**, *relay output 2*: **[-03] = Output 3 / DOUT1**, *digital output 1* **[-04] = Output 4 / DOUT2**, *digital output 2* **[-05] = Output 5 / DOUT3**, *digital output 3*			
	Reference to the following values: Current limit (3) = x [%] · P203 >Rated motor current< Torque current limit (4) = x [%] · P203 · P206 (calculated rated motor torque) Frequency limit (5) = x [%] · P201 >Rated motor frequency<			
P436 **[-01] ... [-05]**	**Dig. out. hysteresis** *(Digital output hysteresis)*		**S**	**P**
1 ... 100 % { all 10 }	Difference between switch-on and switch-off point to prevent oscillation of the output signal.			
	[-01] = Output 1 / MFR1, *relay output 1*: **[-02] = Output 2 / MFR2**, *relay output 2*: **[-03] = Output 3 / DOUT1**, *digital output 1* **[-04] = Output 4 / DOUT2**, *digital output 2* **[-05] = Output 5 / DOUT3**, *digital output 3*			

P460	Watchdog time *(Watchdog time)*		S	

-250.0 ... 250.0 s
{ 10.0 }

0.1 ... 250.0 = The time interval between the expected watchdog signals (programmable function of digital inputs P420 …). If this time interval elapses without a pulse being registered, a switch-off occurs with error message E012.

0.0 = Customer error: As soon as a High-Low edge or a Low signal is registered on a digital input (function 8), the FI switches off with fault message E012.

-250.0 … -0.1 = In this setting, the monitoring of the rotor run (watchdog) becomes active. The time is defined by the set value. If the device is switched off, no watchdog message is issued. After each enable, a pulse must first come before the watchdog is activated.

P461	Function 2nd Encoder *(Function 2nd encoder)*		S	

0 ... 5
{ 0 }
from
hardware status CAA

The speed list value supplied by an HTL incremental encoder can be used for various functions in the device. The settings are identical to (P325). The HTL encoder is connected via the digital inputs 2 and 4. Parameters (P421) and (P423) must be set to functions 43 “Signal A” and 44 “Signal B” accordingly. Due to the limiting frequency (max. 10 kHz) of these digital inputs, only restricted encoder resolutions (P462) are possible. The mounting point (motor shaft or output side) of the encoder is considered by parameterising a respective ratio (P463).

0 = Speedmeas. servomode: The speed list value of the motor is used for the servo mode. The ISD control cannot be switched off in this function.

1 = PID actual frequency: The speed list value of a system is used for speed control. This function can also be used for controlling a motor with a linear characteristic curve. Here, P413 and P414 determine the P and I components of the control.

2 = Frequency addition: The determined speed is added to the current setpoint.

3 = Freq. subtraction: The determined speed is subtracted from the current setpoint.

4 = Maximum frequency: The maximum possible output frequency/speed is limited by the current speed of the encoder.

5 = Reserved: see BU510

P462	PPR 2nd Encoder *(PPR 2nd encoder)*		S	

16 ... 8192
{ 1024 }

Input of pulse rate per rotation (16 … 8192) of the connected HTL incremental encoder.
It is the phase sequence of the encoder and not of the motor control device (depending on assembly and wiring). Signal A and B must therefore be switched. For this purpose, the electrical connections of the encoder on the device can be rewired, or the functions of the respective digital inputs can be switched.

P463	2. Encoder ratio *(2nd encoder speed ratio)*		S	

0.01 ... 100.0
{ 1.00 }

If the HTL incremental encoder is not mounted directly on the motor shaft, the correct speed ratio for the motor speed and the encoder speed must be set.

$$P463 = \frac{\text{Motor speed}}{\text{Encoder speed}}$$

Only if P461 = 1, 2, 3 4 or 5, therefore not in Servo mode (motor speed control)

P464	Fixed frequencies mode *(Fixed frequencies mode)*		S	

0 ... 1
{ 0 }

This parameter determines the form in which fixed frequencies are to be processed.

0 = Addition to main setpoint: Fixed frequencies and the fixed frequency array are added to each other. I.e. they are added together, or added to an analog setpoint to which limits are assigned according to P104 and P105.

1 = Main setpoint: Fixed frequencies are not added - neither together, nor to analog setpoints. If for example, a fixed frequency is switched to an existing analog setpoint, the analog setpoint will no longer be considered.
Programmed frequency addition or subtraction with an analog input value or a bus setpoint is still possible and valid, as is the addition to the setpoint of a motor potentiometer function (function of digital inputs: 71/72)
If several fixed frequencies are selected simultaneously, the frequency with the highest value has priority (E.g.: 20>10 or 20>-30).
Note:
The highest active fixed frequency is added to the setpoint value of the motor potentiometer if the functions 71 or 72 are selected for 2 digital inputs.

P465 [-01] ... [-31]	Fixed freq. Array *(Fixed frequency / Array)*			

-400.0 ... 400.0 Hz
{ 0.0 }

In the array levels, up to 31 different fixed frequencies can be set, which in turn can be encoded for the functions 50…54 in binary code for the digital inputs.

P466	Min.freq. process cont. *(Minimum frequency process controller)*		S	P

0.0 ... 400.0 Hz
{ 0.0 }

With the aid of the minimum frequency process controller the control ratio can also be kept to a minimum ratio, even with a master value of “zero”, in order to enable adjustment of the compensator. More details can be found in P400 and (see chapter 8.2 "Process controller").

P468	Speed controller with HTL *(Speed controller with HTL encoder)*		S	P

0 ... 1
{ 0 }

Activates speed control by the HTL encoder However, this setting is ignored of parameter P300 is set to "ON". In this case, the TTL encoder is used for speed control.

In this way, e.g. 2 rotary encoders (a TTL encoder via P300 and an HTL encoder via P468) can be alternately activated via the 4 parameter sets of the FI.

In order to use an HL encoder, parameters P420 [-02] and [-04] as well as P461 … P463 must be parameterised.

0 = OFF
1 = ON

P475 [-01] ... [-10]	delay on/off switch *(Digital function switch on/off delay)*		S	

-30,000 ... 30,000 sec
{ all 0,000 }

Adjustable switch-on/off delay for the digital inputs and the digital functions of the analog inputs. Use as a switch-on filter or simple process control is possible.

[-01] =	Digital input 1	**[-06] =**	Digital input 6 (above SK 520E)
[-02] =	Digital input 2	**[-07] =**	Digital input 7 (above SK 520E)
[-03] =	Digital input 3	**[-08] =**	Digital function, analog input 1
[-04] =	Digital input 4	**[-09] =**	Digital function, analog input 2
[-05] =	Digital input 5	**[-10] =**	Digital input 8 (above SK 540E)

Positive values = switch-on delayed **Negative values =** switch-off delayed

P480 [-01] ... [-12] Functional BusIO In Bits

(Bus I/O In Bits function)

S

0 ... 80
{ all 0 }

The Bus I/O In Bits are perceived as digital inputs (P420). They can be set to the same functions.

In order to use this function, one of the bus setpoints (P546) must be set to >Bus I/O In Bits 0-7 <. The required function must then be assigned to the relevant bit.

With the SK 54xE in association with IO extension modules (e.g. SK TU41OE) these I/O bits can also process their input signals.

array	… SK 535E	SK 54xE	Comments
[-01] =	Bus / AS-i Dig In1	Bus / 2.IOE Dig In1	(Bus I/O In Bit 0)
[-02] =	Bus / AS-i Dig In2	Bus / 2.IOE Dig In2	(Bus I/O In Bit 1)
[-03] =	Bus / AS-i Dig In3	Bus / 2.IOE Dig In3	(Bus I/O In Bit 2)
[-04] =	Bus / AS-i Dig In4	Bus / 2.IOE Dig In4	(Bus I/O In Bit 3)
[-05] =	AS-i Initiator 1	Bus / 1.IOE Dig In1	(Bus I/O In Bit 4)
[-06] =	AS-i Initiator 2	Bus / 1.IOE Dig In2	(Bus I/O In Bit 5)
[-07] =	AS-i Initiator 3	Bus / 1.IOE Dig In3	(Bus I/O In Bit 6)
[-08] =	AS-i Initiator 4	Bus / 1.IOE Dig In4	(Bus I/O In Bit 7)
[-09] =	Flag 1 [1]		
[-10] =	Flag 2 [1]		
[-11] =	Bit 8 Bus control word		
[-12] =	Bit 9 Bus control word		

The possible functions for the Bus In Bits can be found in the table of functions for the digital inputs. Function {14} "Remote control" is not possible.

1) The flag function is only possible with control via control terminals.

P481 [-01] ... [-10] Funct-BusIO Out Bits

(Function BusIO Out Bits)

S

0 ... 40
{ all 0 }

The BusIO Out Bits are considered to be digital outputs (**P434**). They can be set to the same functions.

In order to use this function, one of the bus actual values (**P543**) must be set to > BusIO Out Bits 0-7 <. The required function must then be assigned to the relevant bit.

For the SK 54xE, in association with IO extension modules, these IO Out Bits can also control their digital outputs.

Array	… SK 535E	SK 54xE	Comment
[-01] =	Bus / AS-i Dig Out1	Bus / AS-i Dig Out1	(BusIO Out Bits 0)
[-02] =	Bus / AS-i Dig Out2	Bus / AS-i Dig Out2	(BusIO Out Bits 1)
[-03] =	Bus / AS-i Dig Out3	Bus / AS-i Dig Out3	(BusIO Out Bits 2)
[-04] =	Bus / AS-i Dig Out4	Bus / AS-i Dig Out4	(BusIO Out Bits 3)
[-05] =	AS-i Actuator 1	Bus / 1st IOE Dig Out1	(BusIO Out Bits 4)
[-06] =	AS-i Actuator 2	Bus / 1st IOE Dig Out2	(BusIO Out Bits 5)
[-07] =	Marker 1 [1]	Bus / 2nd IOE Dig Out1	(BusIO Out Bits 6)
[-08] =	Marker 2 [1]	Bus / 2nd IOE Dig Out2	(BusIO Out Bits 7)
[-09] =	Bus statusword Bit10		
[-10] =	Bus statusword Bit13		
[-11] =			
[-12] =			

The possible functions for the Bus Out Bits can be found in the table of functions for the digital outputs or relays.

More details can be found in the AS-Interface manual (BU 0090).

[1] Marker function only possible for control via control terminals

P480 … P481 Use of the marker

With the aid of the marker it is possible to define simple logical sequences of functions.
For this, the “trigger” of a function is defined in the arrays [-07] “Flag 1” and [-08] “Flag 2” (e.g. an overtemperature warning from the motor PTC) of parameter P481. The function which the frequency inverter is to perform if the “trigger” is active is assigned in arrays [-09] and [-10] of parameter P480. I.e. parameter P480 determines the response of the frequency inverter.

Example:

In an application, the frequency inverter is to reduce the actual speed immediately (e.g. with an active fixed frequency) if the motor is in the overtemperature range (“Overtemp. motor PTC”). This is to be implemented by “Deactivation of analog input 1” via the setpoint used in this example.
This is to ensure that the load on the motor drops and the temperature can stabilise again, and that the drive systematically reduces its speed to a defined amount before a fault shutdown occurs.

Step	Description	Function
1	Specify trigger Set Flag 1 to function “Motor overtemperature warning“	P481 [-07] → Function“ 12“
2	Specify the response Set Flag 1 to the function “Setpoint 1 on/off	P480 [-09] → Function“ 19“

Depending on the function selected in (P481) the function must be inverted by adjusting the scaling (P482).

P482 [-01] … [-10] Norm. BusIO Out Bits

(Scaling of bus I/O Out bits)

S

-400…400 %
{ all 100 }

Adjustment of the limit values of the relay functions/Bus Out Bits. For a negative value, the output function will be output negative.
When the limit value is reached and the setting values are positive, the relay contact closes, with negative setting values the relay contact opens.
The assignment of the arrays correspond to those of parameter (P481).

P483 [-01] … [-10] Hyst. BusIO Out Bits

(Hysteresis of bus I/O Out bits)

S

1…100 %
{ all 10 }

Difference between switch-on and switch-off point to prevent oscillation of the output signal.
The assignment of the arrays correspond to those of parameter (P481).

5.1.6 Additional parameters

Parameter {factory setting}	Setting value / Description / Note		Supervisor	Parameter set
P501 **[-01] ... [-20]**	**Inverter name** *(Inverter name)*			
A…Z (char) { 0 }	Free input of a designation (name) for the device (max. 20 characters). With this, the frequency inverter can be uniquely identified for setting with NORD CON software or within a network.			
P502 **[-01] ... [-05]**	**Value Masterfunction** *(Value master function)*		**S**	**P**
0 ... 57 { all 0 }	Selection of the master value of a Master for output to a bus system (see P503) - (up to SK 535E: max. 3 master values, SK 540 and above: max. 5 master values). The assignment of these master values to the slave is carried out via (P546) (...(P548)):			
	[-01] = Master value 1 **[-02] =** Master value 2 **[-03] =** Master value 3			
	SK 540E and above: **[-04] =** Master value 4 **[-05] =** Master value 5			
	Selection of possible setting values for master values:			
	00 = Off **01 =** Actual frequency **02 =** Actual speed **03 =** Electricity **04 =** Torque current **05 =** State digital-IO **06 =** *Reserved* **07 =** *Reserved* **08 =** Set point frequency	**09 =** Error code **10 =** *Reserved* **11 =** *Reserved* **12 =** BusIO Out Bits 0-7 **13 =** *Reserved* **14 =** *Reserved* **15 =** *Reserved* **16 =** *Reserved* **17 =** Value analog input 1 **18 =** Value analog input 2	**19 =** Frequency master value **20 =** Setpoint freq. after ramp **21 =** Actual freq. w/o slip **22 =** Speed encoder **23 =** Actual freq. with slip (SW V2.0 and above) **24 =** Act. freq. with slip (SW V2.0 and above) **53 =** *... 57 Reserved*	
	NOTE: For details regarding the processing of setpoints and actual values, pleas refer to Section 8.9.			
P503	**Master function output** *(Master function output)*		**S**	
0 ... 5 { 0 }	For master-slave applications this parameter specifies on which bus system the master transmits the control word and the master values (P502) for the slave. On the slave, parameters (P509), (P510), (P546 ...) define the source from which the slave obtains the control word and the master values from the master and how these are to be processed by the slave.			
	0 = Off: no output of control word and master values.			
	1 = USS: output of control words and master values to USS.			
	2 = CAN: output of control words and master values to CAN (up to 250 kBaud).			
	3 = CANopen: output of control words and master values to CANopen.			
	4 = System bus active: no output of control word and master values, however via the ParameterBox or NORD CON, all participants which are set to ***System bus active*** are visible.			
	5 = CANopen+Sys.bus active: output of control word and master values on CAN open via the ParameterBox or NORD CON, all participants which are set to ***system bus active*** are visible.			

P504	**Pulse frequency** *(Pulse frequency)*		S	

3.0 ... 16.4 kHz
{ 6.0 / 4.0 }

The internal pulse frequency for controlling the power unit can be changed with this parameter. A higher setting reduces motor noise, but leads to increased EMC emissions and reduction of the possible motor nominal torque.

NOTE: The best possible degree of interference suppression for the device is adhered to by using the default value and taking the wiring directives into consideration.

NOTE: Raising the pulse frequency leads to a reduction of the possible output current, depending on the time (I^2t curve). When the temperature warning limit (C001) is reached, the pulse frequency is gradually lowered to the default value. If the inverter temperature drops by a sufficient amount, the pulse frequency is increased to the original value.

With size 8 and higher, the maximum adjustable pulse frequency is 8 kHz.

NOTE: *Setting **16.1***: The automatic adaptation of the pulse frequency is activated with this setting. When doing this, the frequency inverter permanently determines the maximum possible pulse frequency taking different influential factors into consideration such as the heat sink temperature or an overcurrent warning

NOTE: In case of overload of the frequency inverter, the pulse frequency is reduced automatically, depending on the instantaneous degree of overload, in order to prevent an overcurrent shut-down (see also **P537**).

However, the use of a sine wave filter requires a constant pulse frequency at all times, as otherwise "Module error" (**E4.0**) shut-downs will be triggered.

The necessary constant pulse frequencies are selected with the following settings:

*Setting **16.2***: 6 kHz

*Setting **16.3***: 8 kHz

NB: With these settings, short circuits at the output which occur before enabling may possibly not be detected correctly.

NOTE: *Setting **16.4***: Automatic load adjustment

The pulse frequency is automatically adjusted between a minimum value (highest load reserve) and a maximum value (lowest load reserve) depending on the load.

During an acceleration phase and if high power is required (≥ rated power) the minimum value is set. With constant speed and a power requirement ≤ 80 % to the rated power, the high pulse frequency is set..

P505	**Absolute mini. freq.** *(Absolute minimum frequency)*		S	P

0.0 ... 10.0 Hz
{ 2.0 }

Specifies the frequency value that cannot be undershot by the FI. If the setpoint becomes smaller than the abs. minimum frequency, the FI switches off or changes to 0.0 Hz.

At the absolute minimum frequency, brake control (P434) and setpoint delay (P107) are executed. If a setting value of “Zero” is selected, the brake relay does not switch during reversing.

In case of encoder-less drives for lifting gear applications, this value should be set to a minimum of 2 Hz. With 2 Hz and higher, the current control of the FI operates and a connected motor can supply sufficient torque.

NOTE:
Output frequencies < 4.5 Hz result in current limitation (see chapter 8.4 "Reduced output power").

P506	**Automatic error acknowledgement** *(Automatic error acknowledgement)*		S	
0 ... 7 { 0 }	In addition to the manual error acknowledgement, an automatic one can also be selected. **0 =** **No automatic** error acknowledgement. **1 ... 5 =** **Number**of permissible automatic error acknowledgements within one mains-on cycle. After mains off and switch on again, the full amount is again available. **6 =** **Always:** an error message will always be acknowledged automatically if the cause of the error is no longer present. **7 =** **Via Deactivate enable:** acknowledgement is only possible using the OK / ENTER key or by mains switch-off. No acknowledgement is implemented by removing the enable! **NOTE:** If (P428) is parameterised to "ON", parameter (P506) "Automatic error acknowledgement" must not be parameterised to setting 6 "Always" as otherwise the device or system is endangered due to the possibility of continuous restarting in the case of an active error (e.g. short-circuit to earth / short circuit).			

P507	**PPO-Type** *(PPO-Type)*			
1 ... 4 { 1 }	This parameter can only be used with the technology unit Profibus, DeviceNet or InterBus. See also the relevant section of the corresponding supplementary BUS manual.			

P508	**Profibus address** *(Profibus address)*			
1 ... 126 { 1 }	Profibus address, only with the technology unit Profibus See also the additional description for the Profibus control BU 2700			

P509	**Source Control Word** *(Source control word)*			
0 ... 10 { 0 }	Selection of the interface via which the FI is controlled. **0 = Control terminals or keyboard control** ** with the ControlBox (if P510=0), the ParameterBox (not ext. p-box) or via BUS I/O Bits. **1 = Only control terminals** , the FI can only be controlled via the digital and analog inputs or via the bus I/O Bits. **2 = USS** control word *, the control signals (enable, direction of rotation, ...) are transferred via the RS485 interface. The setpoint is transferred via the analog input or the fixed frequencies. This setting should also be selected if communication via Modbus RTU is intended. The frequency inverter automatically detects whether this is a USS protocol or a Modbus protocol. **3 = CAN** control word * **4 = Profibus** control word * **5 = InterBus** control word * **6 = CANopen** control word * **7 = DeviceNet** control word * **8 = Ethernet TU*** ** control word* **9 = CAN Broadcast *** **10 = CANopen Broadcast ***			

NOTE:
For details about the respective Bus systems please refer to the respective Options descriptions.
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*) Keyboard control (ControlBox, ParameterBox, PotentiometerBox) is blocked, parameterisation is still possible.

**) If the communication during keyboard control is interrupted (time out 0.5 sec), the FI will block without an error message.

***) The **Ethernet TU** setting must be used for all NORD Ethernet-based bus systems (e.g.: EtherCAT: SK TU3-ECT, PROFINET: SK TU3-PNT).

Note: Parameterisation of a frequency inverter via a field bus connection requires parameter (P509) "Control Terminals" to be set to the appropriate bus system

P510 [-01] [-02] Setpoint source

(Setpoint source)

S

0 ... 10
{ all 0 }

Selection of the setpoint source to be parameterised.

[-01] = Main **setpoint source** **[-02] =** Auxiliary **setpoint source**

Selection of the interface via which the FI receives the setpoint.

0 = Auto (=P509): The source of the auxiliary setpoint is automatically derived from the setting in the parameter P509 >Interface<

1 = Control terminals, digital and analog inputs control the frequency, including fixed frequencies

2 = USS (or Modbus RTU**)**

3 = CAN

4 = Profibus
5 = InterBus
6 = CANopen
7 = DeviceNet
8 = Ethernet TU
9 = CAN Broadcast
10 = CANopen Broadcast

P511 USS baud rate

(USS baud rate)

S

0 ... 8
{ 3 }

Setting of the transfer rate (transfer speed) via the RS485 interface. All bus participants must have the same baud rate setting.

		SK 54xE and above:	
0 =	4,800 Baud	**4 =**	57,600 Baud
1 =	9,600 Baud	**5 =**	115,200 Baud
2 =	19,200 Baud	**6 =**	187,750 Baud
3 =	38,400 Baud	**7 =**	230,400 Baud
		8 =	460,800 Baud

NOTE: For communication via Modbus a transfer rate of maximum 38400 Baud must be set.

P512 USS address

(USS address)

0 ... 30
{ 0 }

Setting of the FI bus address for USS communication.

P513 Telegram time-out

(Telegram time out)

S

-0.1 / 0.0 / 0.1 ... 1000 s
{ 0.0 }

Monitoring function of the active bus interface. Following receipt of a valid telegram, the next one must arrive within the set period. Otherwise the FI reports an error and switches off with the error message E010 >Bus Time Out<.

0.0 = Off: Monitoring is switched off.

-0.1 = No error: Even if communication between BusBox and FI is interrupted (e.g. 24V error, Box removed, etc.), the FI will continue to operate unchanged.

NOTE: The process data channels for USS, CAN/CANopen and CANopen Broadcast are monitoring independently of each other. The decision concerning which channel to monitor is made by means of the setting in parameters P509 and P510.

For example, in this way it is possible to register the interruption of a CAN Broadcast communication, although the FI is still communicating with a Master via CAN.

P514 CAN bus baud rate

(CAN bus baud rate)

0 ... 7
{ 4 }

Setting of the transfer rate (transfer speed) via the CANbus interface. All bus participants must have the same baud rate setting. When using the CANopen technology unit, the settings from this parameter are only valid, if the BAUD rotary encoding switch of the technology unit was set to **PGM**.

0 = 10 kBaud
1 = 20 kBaud
2 = 50 kBaud
3 = 100 kBaud
4 = 125 kBaud
5 = 250 kBaud
6 = 500 kBaud
7 = 1 Mbaud * (for test purposes only)

*) Reliable operation cannot be guaranteed

Information

The baud rate is only applied after a power on, a reset node message or a power on of the 24 V bus supply.

P515 [-01] ... [-03] CAN bus address

(CAN bus address)

0 ... 255
{ all 50 }

Setting of the basic CANbus address for CAN and CANopen. When using the CANopen technology unit, the settings from this parameter are only valid, if the BAUD rotary encoding switch of the technology unit was set to **PGM**.

Information

Data transfer

The address is only applied after a power on, a reset node message or a power on of the 24 V bus supply.

With software 1.6 and higher, adjustable in three levels:

[-01] = Slave address: Reception address for CAN and CANopen (as before)
[-02] = Broadcast slave adr.: Broadcast reception address for CANopen (slave)
[-03] = Master address: Broadcast transmission address for CANopen (master)

P516 Skip frequency 1

(Skip frequency 1)

		S	P

0.0 ... 400.0 Hz
{ 0.0 }

The output frequency around the frequency value (P517) set here is not shown.
This range is transmitted with the set brake and acceleration ramp; it cannot be continuously supplied to the output. Frequencies below the absolute minimum frequency should not be set.

0 = Skip frequency inactive

P517 Skip freq. area 1

(Skip frequency area 1)

		S	P

0.0 ... 50.0 Hz
{ 2.0 }

Skip range for the >Skip frequency 1< P516. This frequency value is added and subtracted from the skip frequency.

Skip frequency range 1: P516 - P517 ... P516 + P517

P518 Skip frequency 2

(Skip frequency 2)

		S	P

0.0 ... 400.0 Hz
{ 0.0 }

The output frequency around the set frequency value (P519) is skipped.
This range is transmitted with the set brake and acceleration ramp; it cannot be continuously supplied to the output. Frequencies below the absolute minimum frequency should not be set.

0 = Skip frequency inactive

P519	**Skip freq. area 2** *(Skip frequency area 2)*		S	P
0.0 ... 50.0 Hz { 2.0 }	Skip range for the >Skip frequency 2< P518. This frequency value is added and subtracted from the skip frequency. Skip frequency range 2: P518 - P519 ... P518 + P519			

P520	**Flying start** *(Flying start)*		S	P
0 ... 4 { 0 }	This function is required to connect the FI to already rotating motors, e.g. in fan drives. Motor frequencies >100Hz are only picked up in speed controlled mode (Servo mode P300 = ON). **0 = Switched off**, no flying start. **1 = Both directions**, the FI looks for a speed in both directions. **2 = Setpoint value direction**, searches only in the direction of the setpoint val. which is present. **3 = Both directions after failure**, as for { 1 }, however only after mains failure or fault **4 = Setpoint direction after fail**, as for{ 2 }, however only after mains failure or fault			

NOTE: For physical reasons, the flying start circuit only operates above 1/10 of the nominal motor frequency (P201), however, not below 10Hz.

	Example 1	**Example 2**
(P201)	50Hz	200Hz
f=1/10*(P201)	f=5Hz	f=20Hz
Comparison of f with f_{min} with: f_{min} =10Hz **Result f_{Fang}=**	5Hz < 10Hz The flying start circuit functions above **f_{Fang}=10Hz.**	20Hz < 10Hz The flying start circuit functions above **f_{Fang}=20Hz.**

NOTE: *PMSM*: The catch function automatically determines the direction of rotation. The device therefore behaves in an identical way to function 1 with the setting for function 2. The device behaves in an identical way to function 3 with the setting for function 4.

In CFC closed loop operation, the catch circuit can only be executed if the rotor position is known in relation to the incremental encoder. For this purpose, the motor can initially not rotate when it is switched on for the first time after a "mains on" of the device.

This restriction does not apply if the zero track of the incremental encoder is used.

NOTE: *PMSM*: The flying restart does not function if fixed pulse frequencies (setting **16.2** and **16.3**) are used in **P504**.

P521	**Fly. start resol.** *(Flying start resolution)*		S	P
0.02... 2.50 Hz { 0.05 }	Using this parameter, the flying start circuit search increment size can be adjusted. Values that are too large affect accuracy and causes the FI to cut out with an overcurrent message. If the values are too small, the search time is greatly extended.			

P522	**Fly. start offset** *(Flying start offset)*		S	P
-10.0 ... 10.0 Hz { 0.0 }	A frequency value that can be added to the frequency value found, e.g. to remain in the motor range and so avoid the generator range and therefore the chopper range.			

P523	Factory setting *(Factory setting)*			
0 ... 2 { 0 }	By selecting the appropriate value and confirming it with the ENTER key, the selected parameter range is entered in the factory setting. Once the setting has been made, the value of the parameter returns automatically to 0. **0 = No change:** Does not change the parameterisation. **1 = Load factory settings:** The complete parameterisation of the FI reverts to the factory setting. All originally parameterised data are lost. **2 = Factory settings without bus:** All parameters of the frequency inverter with the exception of the bus parameter, are reset to the factory setting.			

P525 [-01] ... [-03]	Load control max *(Load monitoring maximum value)*		S	P
1 ... 400 % / 401 { all 401 }	Selection of up to 3 auxiliary values: **[-01] = Auxiliary value 1** **[-02] = Auxiliary value 2** **[-03] = Auxiliary value 3** Maximum load torque value. Setting of the upper limit of load monitoring. Up to 3 values can be specified. Prefixes are not taken into account, only the integer values are processed (motor / generator torque, right/left rotation). The array elements [-01], [-02] and [-03] of parameters (P525) … (P527), or the entries which are made there always belong together. **401 = OFF** Means that the function is switched off. No monitoring is performed. This is also the basic setting for the FI.			

P526 [-01] ... [-03]	Load control min *(Load monitoring, minimum value)*		S	P
0 ... 400 % { all 0 }	Selection of up to 3 auxiliary values: **[-01] = Auxiliary value 1** **[-02] = Auxiliary value 2** **[-03] = Auxiliary value 3** Minimum load torque. Setting of the lower limit value of load monitoring. Up to 3 values can be specified. Prefixes are not taken into account, only the integer values are processed (motor / generator torque, right/left rotation). The array elements [-01], [-02] and [-03] of parameters (P525) … (P527), or the entries which are made there always belong together. **0 = OFF** Means that the function is switched off. No monitoring is performed. This is also the basic setting for the FI.			

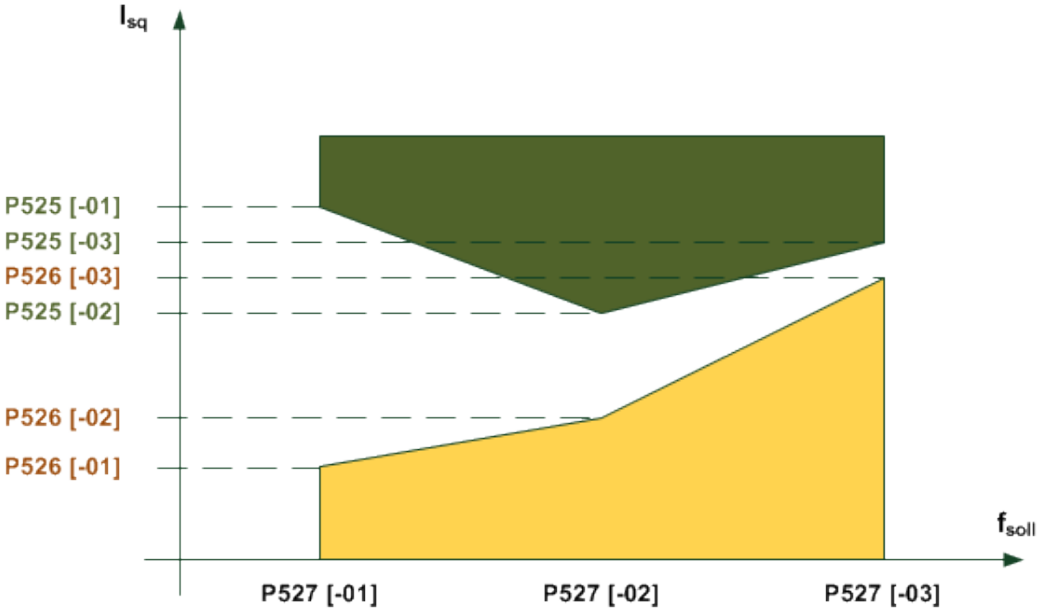
P527 [-01] ... [-03]	Load control freq. *(Load monitoring frequency)*		S	P
0.0 ... 400.0 Hz { all 25.0 }	Selection of up to 3 auxiliary values: **[-01] = Auxiliary value 1** **[-02] = Auxiliary value 2** **[-03] = Auxiliary value 3** Auxiliary frequency values Definition of up to 3 frequency points, which define the monitoring range for load monitoring. The auxiliary frequency values do not need to be entered in order of size. Prefixes are not taken into account, only the integer values are processed (motor / generator torque, right/left rotation). The array elements [-01], [-02] and [-03] of parameters (P525) … (P527), or the entries which are made there always belong together.			

P528	**Load control delay** *(Load monitoring delay)*		S	P
0.10 ... 320.00 s { 2.00 }	Parameter (P528) defines the delay time for which an error message ("E12.5") is suppressed on infringement of the defined monitoring range ((P525) … (P527)). A warning ("C12.5") is triggered after half of this time has elapsed. According to the selected monitoring mode (P529) an error message can also be generally suppressed.			

P529	**Mode Load control** *(Load monitoring mode)*		S	P
0 ... 3 { 0 }	The reaction of the frequency inverter to an infringement of the defined monitoring range ((P525) … (P527)) after the elapse of the delay time (P528) is specified by parameter (P529). **0 =** **Fault and warning**, After the elapse of the time defined in (P528), an infringement of the monitoring range produces a fault ("E12.5"). A warning ("C12.5") is given after the elapse of half of this time. 1 = **Warning**, After the elapse of half of the time defined in (P528) and infringement of the monitoring range produces a warning ("C12.5"). 2 = **Error and warning, constant travel**, "*Error and warning during constant travel*", as for setting "0" however monitoring is inactive during acceleration phases. 3 = **Warning constant travel**, "*Only warning during constant travel*", as for setting "1", however monitoring is inactive during acceleration phases.			

P525 … P529 Load monitoring

With the load monitoring, a range can be specified within which the load torque may change depending on the output frequency. There are three auxiliary values for the maximum permissible torque and three auxiliary values for the minimum permissible torque. A frequency is assigned to each of these auxiliary values. No monitoring is carried out below the first and above the third frequency. In addition, the monitoring can be deactivated for minimum and maximum values. As standard, monitoring is deactivated.



The time after which a fault is triggered can be set with parameter (P528). If the permissible range is exceeded *(Example diagram: Infringement of the area marked in yellow or green*), the error message **E12.5** is generated unless parameter (P529) does not suppress the triggering of an error.

A warning **C12.5** is always given after the elapse of half of the set error triggering time (P528). This also applies if a mode is selected for which no fault message is generated. If only a maximum or minimum value is to be monitored, the other limit must be deactivated or must remain deactivated. The torque current and no the calculated torque is used as the reference value. This has the advantage that monitoring in the "non field weakened range" without servo mode is usually more accurate. Naturally however, it cannot display more than the physical torque in the weakened field range.

All parameters depend on parameter sets. No differentiation is made between motor and generator torque, therefore the value of the torque is considered. As well as this, there is no differentiation between "left" and "right" running. The monitoring is therefore independent of the prefix of the frequency. There are four different load monitoring modes (P529).

The frequencies, and the minimum and maximum values belong together within the various array elements. The frequencies do not need to be sorted according to their magnitude in the elements 0, 1 and 2, as the frequency inverter does this automatically.

P533	**Factor I^2t-Motor** *(Factor I^2t-Motor)*		**S**	
50 ... 150 % { 100 }	The motor current for the I^2t motor monitoring P535 can be weighted with the parameter P533. Larger factors permit larger currents.			

P534	**[-01]** **[-02]**	**Torque disconn. limit** *(Torque disconnection limit)*		**S**	**P**
0 ... 400 % / 401 { all 401 }	Via this parameter both the **drive** [-01] and the **generator** [-02] switch-off value can be adjusted. If 80% of the set value is reached, a warning status is set. At 100% switch-off is performed with an error message. Error 12.1 is given on exceeding the drive switch-off limit and 12.2on exceeding the generator switch-off limit. **[01] =** drive switch-off limit **[02] =** generator switch-off limit **401 = OFF** means that this function has been disabled.				

P535	**I^2t motor** *(I^2t motor)*			

0 … 24
{ 0 }

The motor temperature is calculated depending on the output current, the time and the output frequency (cooling). If the temperature limit value is reached, a switch-off occurs with error message E002 (motor overheating). Possible positive or negative acting ambient conditions cannot be taken into account here.

The I^2t motor function can be set in a differentiated manner. Eight characteristic curves with three different triggering times (< 5 s, < 10 s and < 20 s) can be set. The triggering times are based on classes 5, 10 and 20 for semiconductor switching devices. The recommended setting for standard applications is P535=5.

All curves run from 0 Hz to half of the nominal frequency (P201). The full nominal current is available from half of the nominal frequency upwards.

With multi-motor operation, the monitoring must be disabled.

I^2t- motor off: Monitoring is inactive

Switch-off class 5, 60 s at (1.5 x I_N x P533)		Switch-off class 10, 120 s at (1.5 x I_N x P533)		Switch-off class 20, 240 s at (1.5 x I_N x P533)	
I_N at 0 Hz	**P535**	**I_N at 0 Hz**	**P535**	**I_N at 0 Hz**	**P535**
100%	1	100%	9	100%	17
90%	2	90%	10	90%	18
80%	3	80%	11	80%	19
70%	4	70%	12	70%	20
60%	**5**	60%	13	60%	21
50%	6	50%	14	50%	22
40%	7	40%	15	40%	23
30%	8	30%	16	30%	24

NOTE: Switch-off classes 10 and 20 are provided for applications with heavy starting. When using these switch-off classes, it must be ensured that the FI has a sufficiently high overload capacity.

0 ... 1
{ 0 }

Up to and including software version 1.5 R1, the following applies:

0 = Switched off

1 = Switched on (equivalent to setting 5 (see above))

P536	**Current limit** *(Current limit)*		**S**	

0.1 ... 2.0 / 2.1
(x nominal current of FI)
{ 1.5 }

The inverter output current is limited to the set value. If this limit value is reached, the inverter reduces the actual output frequency.

Multiplier with the inverter nominal current, gives the limit value

2.1 = OFF represents the disabling of this limit value.

P537	Pulse disconnection *(Pulse disconnection)*		S	

10 ... 200 % / 201
{ 150 }

This function prevents rapid shutdown of the FI according to the load. With the pulse switch-off enabled, the output current is limited to the set value. This limitation is implemented by brief switching off of individual output stage transistors, the actual output frequency remains unchanged.

10...200 % =	**Limit value in relation to nominal FI current**
201 =	**The function is** so to speak **disabled,** the FI supplies the maximum possible current. However, at the current limit the pulse switch-off can still be active.

NOTE: The value set here can be undershot by a smaller value in P536.

With smaller output frequencies (<4.5 Hz) or higher pulse frequencies (>6 kHz or 8 kHz, P504) the pulse switch-off can be undershot by the power reduction (see chapter 8.4 "Reduced output power").

NOTE: If the pulse switch-off is disabled (P537=201) and a high pulse frequency is selected in parameter P504, the FI automatically reduces the pulse frequency when the power limit is reached. If the load on the FI is reduced again, the pulse frequency increases back to the original value.

P538	Check input voltage *(Check input voltage)*		S	

0 ... 4
{ 3 }

For the safe operation of the frequency inverter, the voltage supply must have a certain quality. If there is an interruption of a phase, or if the supply voltage drops below a specific limit value, the inverter will issue a fault.

Under certain operating conditions, it may be necessary to suppress this fault message. In this case, the input monitoring can be adjusted.

0 = Switched off:	No monitoring of supply voltage.
1 = Phase failure:	Only phase failures will result in a fault message.
2 = Low voltage:	Only overvoltage and undervoltage will result in a fault message.
3 = Phase f. + Low volt:	A phase failure or overvoltage and undervoltage will result in a fault message.
4 = Dc-supply:	For direct supply with DC voltage, the input voltage is firmly assumed to be 480 V. Phase failure and mains undervoltage monitoring are deactivated.

Note: Operation with an impermissible mains voltage can destroy the FI! With 1/3~230 V or 1~115 V devices, the phase failure monitoring does not work!

P539	Output monitoring *(Output monitoring)*		S	P

0 ... 3
{ 0 }

This protective function monitors the output current at the U-V-W terminals and checks for plausibility. In cases of error, the error message E016 is output.

0 = Disabled: Monitoring is not active.

1 = Only motor phases: The output current is measured and checked for symmetry. If an imbalance is present, the FI switches off and outputs the error message E016.

2 = Only magnetisation: At the moment the FI is switched on, the level of the excitation current (field current) is checked. If insufficient excitation current is present, the FI switches off with the error message E016. A motor brake is not released in this phase.

3 = Motor phase + Magnet: Monitoring of the motor phases and magnetisation as in 1 and 2 are combined.

NOTE: This function can be used as an additional protective function for lifting applications, but is not permissible on its own as protection for persons.

P540	**Mode phase sequence** *(Rotation direction mode)*		S	P

0 ... 7
{ 0 }

For safety reasons this parameter can be used to prevent a rotation direction reversal and therefore the incorrect rotation direction.

This function does not operate with active position control (SK 53xE and above, P600 ≠ 0).

0 = No restriction, no restriction of the direction of rotation

1 = Dir. key disabled, the direction key of the ControlBox SK TU3-CTR is disabled.

2 = CW only*, only clockwise direction is possible. The selection of the "incorrect" rotation direction leads to the output of the minimum frequency P104 with the field of rotation R.

3 = CCW only*, only counter-clockwise direction is possible. The selection of the "incorrect" rotation direction leads to the output of the minimum frequency P104 with the field of rotation L.

4 = Enable direction only, rotation direction is only possible according to the enable signal, otherwise 0Hz.

5 = CW only monitored *, *only the clockwise direction is monitored,* only a clockwise field rotation is possible. The selection of the "incorrect" rotation direction leads to the FI switching off (control block).
If necessary, an adequately large setpoint value (>f_{min}) must be observed.

6 = CCW only monitored: *, *only the counter-clockwise direction is monitored*, only a counter-clockwise field rotation is possible. The selection of the "incorrect" rotation direction leads to the FI switching off (control block). If necessary, an adequately large setpoint value (>f_{min}) must be observed.

7 = Only enabled direction monitored, *only the enabled direction is monitored*, rotation is only possible according to the enable signal, otherwise the FI is switched off.

*) Applies to keyboard (SK TU3-) and control terminal actuation, in addition, the direction key on the ControlBox is blocked.

P541	**Set digital outputs** *(Set relays and digital outputs)*		S	

0000 ... 3FFF(hex)
{ 0000 }

This function provides the opportunity to control the relay and the digital outputs independently of the frequency inverter status. To do this, the relevant output must be set to the function "value of P541".

This function can either be used manually or in combination with a bus control.

Bit 0 = Output 1 (K1)
Bit 1 = Output 2 (K2)
Bit 2 = Output 3 (DOUT1)
Bit 3 = Output 4 (DOUT2)
Bit 4 = Dig. AOut 1 (Analog output 1)
Bit 5 = Output 5 (DOUT3) *(SK 540E and above)*
Bit 6 = *reserved*
Bit 7 = *reserved*
Bit 8 = BusIO Out Bit 0
Bit 9 = BusIO Out Bit 1
Bit 10 = BusIO Out Bit 2
Bit 11 = BusIO Out Bit 3
Bit 12 = BusIO Out Bit 4
Bit 13 = BusIO Out Bit 5

	Bits 13-12	Bits 11-8	Bits 7-4	Bits 3-0	
Min. value	00 **0**	0000 **0**	0000 **0**	0000 **0**	Binary **hex**
Max. value	11 **3**	1111 **F**	1111 **F**	1111 **F**	Binary **hex**

BUS: The corresponding hex value is written into the parameter, thereby setting the relay and digital outputs.

ControlBox: The hexadecimal code is entered directly when the ControlBox is used.

ParameterBox: Each individual output can be separately called up in plain text and activated.

NOTE: The setting is not saved in the EEPROM and is lost when the frequency inverter is switched off!

P542	[-01] ... [-03]	Set analog output *(Set analog output)*		S	

0.0 ... 10.0 V
{ all 0.0 }

[-01] = Analog output: analog output integrated into the FI

[-02] = First IOE, *"External analog output of first IOE"*: Analog output of the first IO extension (SK xU4-IOE)

[-03] = Second IOE, *"External analog output of second IOE"*: Analog output of the second IO extension (SK xU4-IOE)

This function enables the setting of the analog outputs of the FI or the connected IO extension module (SK xU4) regardless of their actual operating statuses. To do this, the relevant output must be set to the function "External control" (e.g.: P418 = 7).

This function can either be used manually or in combination with a bus control. The value set here will, once confirmed, be produced at the analog output.

NOTE: The setting is not saved in the EEPROM and is lost when the frequency inverter is switched off!

P543	[-01] ... [-05]	Bus actual value *(Bus – Actual value)*		S	P

0 ... 57
{ [-01] = 1 }
{ [-02] = 4 }
{ [-03] = 9 }
{ [-04] = 0 }
{ [-05] = 0 }

In this parameter the return status value for bus actuation can be selected.

NOTE: The actual values 4 and 5 must be supported by the relevant bus module. For further details please refer to the manual for the frequency inverter (P418, P543), the relevant BUS operating instructions or the manuals BU 0510 / BU0550.

[-01] = Bus - Actual value 1 **[-02] =** Bus - Actual value 2 **[-03] =** Bus - Actual value 3

[-04] = Bus - Actual value 4 **[-05] =** Bus - Actual value 5

0 =	Off	**13 =**	... 16 Reserved
1 =	Actual frequency	**17 =**	Value analog input 1
2 =	Actual speed	**18 =**	Value analog input 2
3 =	Current	**19 =**	Setpoint frequency master value*(P503)*
4 =	Torque current (100% = P112)	**20 =**	Setpoint frequency master value after ramp *"Setpoint frequency master value after ramp"*
5 =	Digital IO status [4]	**21 =**	Act. freq. without slip master value *"Actual frequency without slip master value"*
6 =	... 7 Reserved	**22 =**	Speed encoder *(only possible with SK 520E and encoder feedback)*
8 =	Setpoint frequency	**23 =**	Actual frequency with slip, *"Actual frequency with slip"* *(SW V2.0 and above)*
9 =	Error number	**24 =**	Master value, actual freq. with slip, *"Master value, actual freq. with slip"* *(SW V2.0 and above)*
10 =	... 11 Reserved	**53 =**	*... 57 Reserved*
12 =	BusIO Out Bits 0...7		

Scaling details: (chapter 8.9)

[4] The assignment of the digital inputs in P543/ 544/ 545 = 5

Bit 0 = DigIn 1	Bit 1 = DigIn 2	Bit 2 = DigIn 3	Bit 3 = DigIn 4
Bit 4 = DigIn 5	Bit 5 = DigIn 6 (SK 520E and above)	Bit 6 = DigIn 7 (SK 520E and above)	Bit 7 = Dig. func. AIN1
Bit 8 = Dig. func. AIN1 AIN2	Bit 9 = DigIn 8 (SK 540E and above)	Bit 10 = DigIn 1, 1.IOE (SK 540E and above)	Bit 11 = DigIn 2, 1.IOE (SK 540E and above)
Bit 12 = Out 1/ MFR1	Bit 13 = Out 2/ MFR2	Bit 14 = Out 3/ DOUT1 (SK 520E and above)	Bit 15 = Out 4/ DOUT2 (SK 520E and above)

P546	[-01] ... [-05]	**Digital Bus setpoint** *(Function of bus setpoint)*		S	P

0 ... 57
{ [-01] = 1 }
all other { 0 }

In this parameter, during bus actuation a function is allocated to the setpoint provided.

NOTE: The setpoints 4 and 5 must be supported by the relevant bus module. For further details please refer to the manual for the frequency inverter (P400, P546), the relevant BUS operating instructions or the manuals BU 0510 / BU0550.

[-01] = Bus setpoint 1 **[-02] =** Bus setpoint 2 **[-03] =** Bus setpoint 3

[-04] = Bus setpoint 4 **[-05] =** Bus setpoint 5

0 =	Off	**16 =**	Add. process control
1 =	Set point frequency	**17 =**	BusIO In Bits 0-7
2 =	Torque current limit *(P112)*	**18 =**	Curve control
3 =	PID current freq.	**19 =**	Set Relais, *"Output status"* (P434/441/450/455 = 38)
4 =	Frequency addition	**20 =**	Set Analog Out (P418 = 31)
5 =	Frequency subtract.	**21 =**	*… 45 Reserved for SK 530E and higher → BU 0510*
6 =	Current limit *(P536)*	**46 =**	Setval.torque p.reg., *"Set value torque process controller"*
7 =	Maximum frequency *(P105)*	**47 =**	*Reserved for SK 530E and higher → BU 0510*
8 =	PID ltd.current.freq	**48 =**	Motor temperature *(SK 540E and higher)*
9 =	PID suprvsd.cur.freq	**49 =**	Ramp time (*SK 540E and higher*)
10 =	Servo-Mode Torque *(P300)*	**53 =**	d-corr. F Process *(SK 540E and higher)*
11 =	Pre-tension Torque *(P214)*	**54 =**	d-corr. Torque *(SK 540E and higher)*
12 =	*Reserved*	**55 =**	d-corr. F+Torque *(SK 540E and higher)*
13 =	Multiplication	**56 =**	Acceleration time (*SK 540E and higher*)
14 =	Cur.val process ctrl	**57 =**	Deceleration time (*SK 540E*)
15 =	Nom.val process ctrl		

Details on scaling: See Chapter 8.9 "Scaling of setpoint/actual values ".**Fehler! Verweisquelle konnte nicht gefunden werden.**

P549	**Pot Box function** *(PotentiometerBox function)*		S	

0 ... 16
{ 0 }

In this parameter, the setpoint of the PotentiometerBox (SK TU3-POT) is assigned with a function. (An explanation can be found in the description of P400.)

As of software version 1.7 R0, on setting 4 or 5, the ControlBox or the ParameterBox are also set to function as suppliers of auxiliary setpoints (see Section 4.5).

0 = Off	**8 =** Actual PID frequency limited
1 = Setpoint frequency	**9 =** Actual PID frequency monitored
2 = Torque current limit	**10 =** Servo mode torque
3 = Actual frequency PID	**11 =** Torque precontrol
4 = Frequency addition	**12 =** *Reserved*
5 = Frequency subtraction	**13 =** Multiplication
6 = Current limit	**14 =** Process controller actual value
7 = Maximum frequency	**15 =** Process controller setpoint
	16 = Process controller lead

P550 Back up data record

(Back up data record)

0 ... 3
{ 0 }

Within the optional ControlBox it is possible to save a data set (parameter set 1 … 4) of the connected FI. This is saved in a non-volatile memory within the Box, and can therefore be transferred for other SK 5xxE units with the same database version (see P742).

0 = No change

1 = FI → ControlBox, the dataset is written from the connected FI to the ControlBox.

2 = ControlBox → FI, the dataset is written from the ControlBox to the connected FI.

3 = FI ←→ ControlBox, the FI dataset is exchanged with the ControlBox dataset. With this variant, no data is lost. It is continuously exchangeable.

NOTE: If parameterisation from old FI's need to be loaded into FIs with new software (P707), then the ControlBox must previously be written to by the new FI (P550 = 1). The dataset to be copied from the old FI can then be read out and copied to the new FI.

P551 Drive profile

(Drive profile)

S

0 … 1
{ 0 }

Depending on the option, this parameter activates the respective process data profiles.

System	CANopen	DeviceNet	InterBus
Technology module	SK TUx-CAO	SK TUx-DEV	SK TUx-IBS
Setting			
0 = OFF =	USS protocol (“Nord” profile)		
1 = ON =	DS402 profile	AC-Drives profile	Drivecom profile

Information

Profile activation

This parameter is only effective for plug-on technology modules (SK TUx-…).

P552 [-01] [-02] CAN master circle

(CAN master cycle time)

S

0 … 100 ms
{ all 0 }

In this parameter, the cycle time for the CAN/CANopen master mode and the CANopen encoder is set (see P503/514/515):

[-01] = CAN Master function, cycle time for CAN/CANopen Master functionality

[-02] = CANopen absolute encoder, cycle time of CANopen absolute encoder

According to the Baud rate set, there are different minimum values for the actual cycle time:

Baud rate	Minimum value t_Z	Default CAN Master	Default CANopen Abs.
10kBaud	10ms	50ms	20ms
20kBaud	10ms	25ms	20ms
50kBaud	5ms	10ms	10ms
100kBaud	2ms	5ms	5ms
125kBaud	2ms	5ms	5ms
250kBaud	1ms	5ms	2ms
500kBaud	1ms	5ms	2ms
1000kBaud:	1ms	5ms	2ms

The range of values which can be set is between 0 and 100ms. With the setting 0 “Auto” the default value (see table) is used. The monitoring function for the CANopen absolute encoder no longer triggers at 50ms, but rather at 150ms.

P553	[-01] ... [-05]	**PLC setpoints** *(PLC setpoints)*		S	P

0 ... 57
all = { 0 }

The PLC setpoints are assigned with a function in this parameter. The settings only apply for main setpoints and with active PLC actuation ((P350) = "On") and ((P351) = "0" or "1").

[-01] = Bus setpoint value 1 … **[-05] = Bus setpoint 5**

Possible values which can be set:

0 =	Off	**17 =**	BusIO In Bits 0-7
1 =	Setpoint frequency	**18 =**	Curve travel calculator
2 =	Torque current limit	**19 =**	Set relays
3 =	Actual frequency PID	**20 =**	Set analogue out
4 =	Frequency addition	**21 =**	Setpoint position Low word
5 =	Frequency subtraction	**22 =**	Setpoint pos. HighWord
6 =	Current limit	**23 =**	Setpoint pos. Inc.LowWord
7 =	Maximum frequency	**24 =**	Target pos.Inc.HighWord
8 =	Actual PID frequency limited	**46 =**	Torque process controller setpoint
9 =	Actual PID frequency monitored	**47 =**	Gearing ratio
10 =	Servo mode torque	**48 =**	Motor temperature
11 =	Torque precontrol	**49 =**	Ramp time
12 =	Reserved	**53 =**	d-correction F process
13 =	Multiplication	**54 =**	d-correction Torque
14 =	Process controller actual value	**55 =**	d-correction F+Torque
15 =	Process controller setpoint	**56 =**	Acceleration time
16 =	Process controller lead	**57 =**	Deceleration time

P554	**Chopper min. threshold** *(Minimum chopper threshold)*		S	

65 ... 101 %
{ 65 }

The switching threshold of the brake chopper can be influenced with this parameter. An optimized value for numerous applications is set in the factory setting. This parameter can be increased for applications where pulsating energy is returned (crank drives) to minimise brake resistance power dissipation.

An increase in this setting leads to a faster overvoltage switch off of the FI.

The setting **101%** also switches off the brake chopper at the 65% switching threshold. In addition, with this setting, monitoring is also active if the FI has not been enabled. I.e. for example if the link circuit voltage in the FI increases above the threshold in "Standby" status (e.g. due to a mains fault), the brake chopper is activated. However, in case of an FI fault, the brake chopper is generally inactive.

P555	Chopper P limitation *(Chopper power limitation)*		S	
5 ... 100 % { 100 }	With this parameter it is possible to program a manual (peak) power limit for the brake resistor. The switch-on delay (modulation level) for the chopper can only rise to a certain maximum specified limit. Once this value has been reached, irrespective of the level of the link voltage, the inverter switches off the current to the resistor. The result would be an overvoltage switch-off of the FI. The correct percentage value is calculated as follows: $k[\%] = \frac{R * P_{\max BW}}{U_{\max}^{2}} * 100\%$ R = Resistance of the brake resistor P_{maxBW} = Momentary peak power of the brake resistor U_{max} = FI chopper switching threshold 1~ 115/230 V ⇒ 440 V= 3~ 230 V ⇒ 500 V= 3~ 400 V ⇒ 1000 V=			

P556	Braking resistor *(Brake resistor)*		S	
20 ... 400 Ω { 120 }	Value of the brake resistance for the calculation of the maximum brake power to protect the resistor. Once the maximum continuous output (**P557**) including overload (200 % for 60 s) is reached, an I^2t limit error (**E003.1**) is triggered. Further details in (**P737**).			

P557	Brake resistor type *(Brake resistor power)*		S	
0.00 ... 320.00 kW { 0.00 }	Continuous power (nominal power) of the resistor, to display the actual utilisation in (**P737**). For a correctly calculated value, the correct value must be entered into (**P556**) and (**P557**). **0.00 =** Monitoring disabled			

P558	Flux delay *(Flux delay)*		S	P
0 / 1 / 2 ... 5000 ms { 1 }	The ISD control can only function correctly if there is a magnetic field in the motor. For this reason, a DC current is applied before starting the motor to provide the excitation of the stator winding. The duration depends on the size of the motor and is automatically set in the factory setting of the FI. For time-critical applications, the magnetizing time can be set or deactivated. **0 =** Disabled **1 =** Automatic calculation **2 ... 5000 =** Time set in [ms] **NOTE:** Setting values that are too low can reduce the dynamics and starting torque.			

P559	DC Run-on time *(DC run-on time)*		S	P
0.00 ... 30.00 s { 0.50 }	After a stop signal and elapse of the brake ramp, direct current is applied to the motor for a short time. This should completely shut down the drive. Depending on the inertia, the time of current application can be set in this parameter. The current level depends on the previous braking procedure (current vector control) or the static boost (linear characteristic curve). **Note:** This function is not possible in closed-loop mode with PMSM!			

P560	**Parameter, Saving mode** *(Saving mode parameter)*		S	

0 ... 2
{ 1 }

0 = **Only in RAM**, changes to the parameter settings are no longer saved on the EEPROM. All previously saved settings are retained, even if the FI is disconnected from the mains.

1 = **RAM and EEPROM**, all parameter changes are automatically written to the EEPROM and remain stored there even if the FI is disconnected from the mains supply.

2 = **OFF**, no saving in RAM and EEPROM possible (no parameter changes are accepted)

NOTE: If BUS communication is used to implement parameter changes, it must be ensured that the maximum number of write cycles (100,000 x) in the EEPROM is not exceeded.

P583	**Motor phase sequence** *(Motor phase sequence)*		S	P

0 ... 2
{ 0 }

The motor phase control sequence (U – V – W) can be changed with this parameter. This enables the phase sequence of the motor to be changed without changing the motor connections.

Note:

If voltage is applied on the output terminals (U – V – W) (e.g. on enabling), the parameter setting must not be changed, and there must be no change to the parameter set, which may result in a change of the setting of parameter **P583**. Otherwise, the device switches off with error message **E016.2**.

Settings

0 = **Normal**: No change, normal phase sequence

1 = **Reversed,** *"Invert motor phase sequence"*: The phase sequence of the motor is changed. The counting direction of the encoder for speed detection (if present) remains unchanged.

2 = **With encod. reversed**: Same as setting "1", but the counting direction of the encoder is also changed.

5.1.7 Positioning

The parameter group P6xx is used to set the POSICON positioning control and is included above the version SK 530E.

A detailed description of these parameters can be found in manual BU 0510. (www.nord.com)

5.1.8 Information

Parameter		Setting value / Description / Note		Supervisor	Parameter set
P700	**[-01] ... [-03]**	**Actual operating status** *(Actual operating status)*			
0.0 ... 25.4		Display of current messages for the present operating status of the frequency inverter such as faults, warnings or the reason why switch-on is disabled (see chapter 6 "Operating status messages"). **[-01] = Present fault,** shows the currently active (unacknowledged) fault (see section "Error messages"). **[-02] = Present warning,** indicates a current warning message (see section "Warning messages"). **[-03] = Reason for disabled starting,** indicates the reason for an active start disable (see section "Switch-on block messages"). **NOTE** *SimpleBox / ControlBox:* the error numbers of the warning messages and faults can be displayed using SimpleBox and ControlBox. *ParameterBox:* with the ParameterBox the messages are displayed in plain text.. In addition, the reason for a possible disabling of starting can also be displayed. *Bus:* The display of bus-level error messages is displayed in decimal integer format. The displayed value must be divided by 10 in order to correspond with the correct format. Example: Display: 20 → Error number: 2.0			
P701	**[-01] ... [-05]**	**Last fault 1 ... 5** *(Last fault 1...5)*			
0.0 ... 25.4		This parameter stores the last 5 faults (see section "Error messages"). The SimpleBox / ControlBox must be used to select the corresponding memory location 1...5- (Array parameter), and confirmed using the OK / ENTER key to read the stored error code.			
P702	**[-01] ... [-05]**	**Last frequency error** *(Last frequency error 1...5)*		**S**	
-400.0 ... 400.0 Hz		This parameter stores the output frequency that was being delivered at the time the fault occurred. The values of the last 5 errors are stored. The SimpleBox / ControlBox must be used to select the corresponding memory location 1...5- (Array parameter), and confirmed using the OK- / ENTER key to read the stored error code.			
P703	**[-01] ... [-05]**	**Current last error** *(Last current error 1...5)*		**S**	
0.0 ... 999.9 A		This parameter stores the output current that was being delivered at the time the fault occurred. The values of the last 5 errors are stored. The SimpleBox / ControlBox must be used to select the corresponding memory location 1...5- (Array parameter), and confirmed using the OK / ENTER key to read the stored error code.			

P704	**[-01] ... [-05]**	**Volt. last error** *(Last voltage error 1...5)*		**S**	

0 ... 600 V AC

This parameter stores the output voltage that was being delivered at the time the fault occurred. The values of the last 5 errors are stored.

The SimpleBox / ControlBox must be used to select the corresponding memory location 1...5- (Array parameter), and confirmed using the OK / ENTER key to read the stored error code.

P705	**[-01] ... [-05]**	**Last link circuit error** *(Last link circuit error 1...5)*		**S**	

0 ... 1000 V DC

This parameter stores the link voltage that was being delivered at the time the error occurred. The values of the last 5 errors are stored.

The SimpleBox / ControlBox must be used to select the corresponding memory location 1...5- (Array parameter), and confirmed using the OK / ENTER key to read the stored error code.

P706	**[-01] ... [-05]**	**P set last error** *(Parameter set last error 1 ... 5)*		**S**	

0 ... 3

This parameter saves the number of the parameter set that was active when the error occurred. Data for the previous 5 errors is saved.

With the SimpleBox/ControlBox, the respective memory slot 1 ... 5 (array parameters) must be selected and confirmed with the OK/ENTER key to read the saved error code.

P707	**[-01] ... [-03]**	**Software-Version** *(Software version/ revision)*			

0.0 ... 9999.9

This parameter shows the software and revision numbers in the FI. This can be significant when different FIs are assigned the same settings.

Array 03 provides information about any special versions of the hardware or software A zero stands for the standard version.

... [-01] = Version number (Vx.x)

... [-02] = Revision number (Rx)

... [-03] = Special version of hardware/software (0.0)

P708 State of digital in.

(Status of digital inputs)

000000000 ... 111111111 (binary) (Display with *SK-TU3-PAR)

or

0000 ... 01FF (hex) (Display with *SK-TU3-CTR *SK-CSX-0)

Displays the status of the digital inputs in binary/hexadecimal code. This display can be used to check the input signals.

Bit 0 = Digital input 1
Bit 1 = Digital input 2
Bit 2 = Digital input 3
Bit 3 = Digital input 4
Bit 4 = Digital input 5
Bit 5 = Digital input 6 *(SK 520E and above)*
Bit 6 = Digital input 7 *(SK 520E and above)*
Bit 7 = Analog input 1 *(digital function)*
Bit 8 = Analog input 2 *(digital function)*
Bit 9 = Digital input 8 *(SK 540E and above)*
Bit 10 = Digital input 1/1 IOE *(SK 540E and above)*
Bit 11 = Digital input 2/1 IOE *(SK 540E and above)*
Bit 12 = Digital input 3/1 IOE *(SK 540E and above)*
Bit 13 = Digital input 4/1 IOE *(SK 540E and above)*
Bit 14 = Digital input 1/2 IOE *(SK 540E and above)*
Bit 15 = Digital input 2/2 IOE *(SK 540E and above)*

	Bits 11-8	Bits 7-4	Bits 3-0	
Minimum value	0000 **0**	0000 **0**	0000 **0**	Binary **hex**
Maximum value	0001 **1**	1111 **F**	1111 **F**	Binary **hex**

ControlBox: the binary Bits are converted into a hexadecimal value and displayed.
ParameterBox: the Bits are displayed increasing from right to left (binary).

P709 [-01] ... [-10] Analog input voltage

(Voltage of analog inputs)

-10.00 ... 10.00 V

Displays the measured analog input value.

[-01] = Analog input 1: analog input 1, integrated into the FI
[-02] = Analog input 2: analog input 2, integrated into the FI
[-03] = External analog input 1, *"External analog input 1"*: Analog input 1 of the first IO extension
[-04] = External analog input 2, *"External analog input 2"*: Analog input 2 of the first IO extension
[-05] = External Analog input 1, 2nd IOE, *"External analog input 1 of the 2nd IOE"*: Analog input 1 of the second IO extension
[-06] = External Analog input 2, 2nd IOE, *"External analog input 2 of the 2nd IOE"*: Analog input 2 of the second IO extension
[-07] = Analog function, Dig2, *"Analog function of digital input 2"*: Analog function of digital input 2 integrated into the FI.
[-08] = Analog function, Dig3, *"Analog function of digital input 3"*: Analog function of digital input 3 integrated into the FI.
[-09] = Encoder track A: Monitoring of the input signal of track A of an incremental encoder (Terminal X6:51/52)
[-10] = Encoder track B Monitoring of the input signal of track B of an incremental encoder (Terminal X6:53/54)

NOTE: The voltage difference between tracks A and B of and incremental encoder can be measured with the aid of parameter P709 [-09] and [-10]. If the incremental encoder is rotated the value of both tracks must jump between -0.8V and 0.8V. For Hiperface encoders the voltage ranges from -0.5V...0.5V. If the voltage only jumps between 0 and 0.8V the relevant rack is faulty. It may be possible to determine the position with the incremental encoder, but the interface is considerably more susceptible to faults. We recommend replacement of the encoder!

P710 **[-01] ... [-03]**	**Analog output voltage** *(Analog output voltage)*			
0.0 ... 10.0 V	Displays the value which is output from the analog output. **[-01] = Analog output**: analog output integrated into the FI **[-02] = First IOE**, *"External analog output of first IOE"*: Analog output 1 of the first IO extension **[-03] = Second IOE**, *"External analog output of second IOE"*: Analog output 1 of the second IO extension			
P711	**State of relays** *(State of digital outputs)*			
000000000 ... 111111111 (binary) (Display with *SK-TU3-PAR) *or* 0000 ... 01FF (hex) (Display with *SK-TU3-CTR *SK-CSX-0)	Displays the actual status of the signal relays. **Bit 0 =** Relay 1 **Bit 1 =** Relay 2 **Bit 2 =** Digital output 1 **Bit 3 =** Digital output 2 **Bit 4 =** Dig. Fct. Aout 1 *(digital function Analog output 1)* **Bit 5 =** Digital output 3 *(SK 540E and above)* **Bit 6 =** Digital output 1/1 IOE *(SK 540E and above)* **Bit 7 =** Digital output 2/1 IOE *(SK 540E and above)* **Bit 8 =** Digital output 1/2 IOE *(SK 540E and above)* **Bit 9 =** Digital output 2/2 IOE *(SK 540E and above)*			
P714	**Operating time** *(Operating time)*			
0.10 ... ___ h	This parameter shows the time for which the FI was connected to the mains and was ready for operation.			
P715	**Running time** *(Enablement time)*			
0.00 ... ___ h	This parameter shows the time for which the FI was enabled and supplied current to the output.			
P716	**Current frequency** *(Actual frequency)*			
-400.0 ... 400.0 Hz	Displays the actual output frequency.			
P717	**Current speed** *(Actual rotation speed)*			
-9999 ... 9999 rpm	Displays the actual motor speed calculated by the FI.			
P718 **[-01] ... [-03]**	**Present Actual setpoint frequency** *(Actual setpoint frequency)*			
-400.0 ... 400.0 Hz	Displays the frequency specified by the setpoint (see chapter 8.1 "Setpoint processing"). **[-01] =** Actual setpoint frequency from the setpoint source **[-02] =** Actual setpoint frequency after processing in the FI status machine **[-03] =** Actual setpoint frequency after frequency ramp			
P719	**Actual current** *(Actual current)*			
0.0 ... 999.9 A	Displays the actual output current.			

P720	Act. torque current *(Actual torque current)*			
-999.9 ... 999.9 A	Displays the actual calculated torque-developing output current (active current). Basis for calculation are the motor data P201...P209. → negative values = generator, → positive values = drive			

P721	Actual field current *(Actual field current)*			
-999.9 ... 999.9 A	Displays the actual calculated field current (reactive current). Basis for calculation are the motor data P201...P209.			

P722	Current voltage *(Actual voltage)*			
0 ... 500 V	Displays the actual AC voltage supplied by the FI output.			

P723	Voltage -d *(Actual voltage component Ud)*		S	
-500 ... 500 V	Displays the actual field voltage component.			

P724	Voltage -q *(Actual voltage component Uq)*		S	
-500 ... 500 V	Displays the actual torque voltage component.			

P725	Current Cos phi *(Actual cosj)*			
0.00 ... 1.00	Displays the actual calculated cos φ of the drive.			

P726	Apparent power *(Apparent power)*			
0.00 ... 300.00 kVA	Displays the actual calculated apparent power. The basis for calculation are the motor data P201...P209.			

P727	Mechanical power *(Mechanical power)*			
-99.99 ... 99.99 kW	Displays the actual calculated effective power of the motor. Basis for calculation are the motor data P201...P209.			

P728	Input voltage *(mains voltage)*			
0 ... 1000 V	Displays the actual mains voltage at the FI input. This is directly determined from the amount of the intermediate circuit voltage			

P729	Torque *(Torque)*			
-400 ... 400 %	Displays the actual calculated torque. Basis for calculation are the motor data P201...P209.			

P730	Field *(Field)*			
0 ... 100 %	Displays the actual field in the motor calculated by the FI. The basis for calculation are the motor data P201...P209.			

P731	**Parameter set** *(Actual parameter set)*			
0 ... 3	Shows the actual operating parameter set. 0 = Parameter set 1 1 = Parameter set 2 2 = Parameter set 3 3 = Parameter set 4			

P732	**Phase U current** *(U phase current)*		**S**	
0.0 ... 999.9 A	Displays the actual U phase current. **NOTE:** This value can deviate somewhat from the value in P719, due to the measurement procedure used, even with symmetrical output currents.			

P733	**Phase V current** *(V phase current)*		**S**	
0.0 ... 999.9 A	Displays the actual V phase current. **NOTE:** This value can deviate somewhat from the value in P719, due to the measurement procedure used, even with symmetrical output currents.			

P734	**Phase W current** *(W phase current)*		**S**	
0.0 ... 999.9 A	Displays the actual W phase current. **NOTE:** This value can deviate somewhat from the value in P719, due to the measurement procedure used, even with symmetrical output currents.			

P735 **[-01] ... [-03]**	**Speed encoder** *(Speed encoder)*		**S**	
-9999 ... 9999 rpm	Displays the actual rotation speed supplied by the incremental encoder. P301 / P462 / P605 must be correctly set according to the type of encoder. **[-01] = TTL Encoder** **[-02] = HTL Encoder** **[-03] = Absolute Encoder**			

P736	**D.c. link voltage** *(DC link voltage)*			
0 ... 1000 V DC	Displays the actual link voltage.			

P737	**Usage rate brakeres.** *(Actual brake resistor usage rate)*			
0 ... 1000 %	This parameter provides information about the actual degree of modulation of the brake chopper or the current utilisation of the braking resistor in generator mode. If parameters P556 and P557 are correctly set, the utilisation related to P557, the resistor power, is displayed. If only P556 is correctly set (P557=0), the degree of modulation of the brake chopper is displayed. Here, 100 means that the brake resistor is fully switched. On the other hand, 0 means that the brake chopper is not active at present. If P556 = 0 and P557 = 0, this parameter also provides information about the degree of modulation of the brake chopper in the FI.			

P738	Usage rate motor *(Actual utilisation of motor)*			
0 ... 1000 %	Shows the actual motor load. Basis for calculation is the motor data P203. The actually recorded current is related to the nominal motor current.			

P739 [-01] ... [-03]	Heatsink temperature *(Actual heat sink temperature)*			
0 ... 150 °C	Displays the actual FI temperature. **[-01] = Heat sink temperature**: Displays the actual FI heat sink temperature. This value is used for overtemperature switch-off (E001), error message 1.0. **[-02] = Internal temperature**: shows the actual internal temperature of the inverter. This value is used for overtemperature switch-off (E001), error message 1.1. **[-03] = Motor temperature KTY temperature**: shows the actual motor temperature when monitoring with a KTY temperature sensor.			

P740 [-01] ... [-23]	Process Data Bus In *(Process data Bus In)*		S	
0000 ... FFFF (hex)	This parameter informs about the actual control word and the setpoints that are transferred via the bus systems. For display, a BUS system must be selected in P509. Standardisation: 8.9 "Scaling of setpoint/actual values "	**[-01] =** Control word	Control word, source from P509.	
		[-02] = set value 1 (P510/1) **[-03] =** set value 2 (P510/1) **[-04] =** set value 3 (P510/1) **[-05] =** set value 4 (P510/1) **[-06] =** set value 5 (P510/1)	Setpoint data from main setpoint (P510 [-01]).	
		[-07] = res. Stat InBit P480	The displayed value depicts all Bus In Bit sources linked with "*OR*".	
		[-08] = Parameter data In 1 **[-09]** = Parameter data In 2 **[-10]** = Parameter data In 3 **[-11]** = Parameter data In 4 **[-12]** = Parameter data In 5	Data during parameter transfer: Order label (AK),Parameter number (PNU), Index (IND), Parameter value (PWE 1/2)	
		[-13] = set value 1 (P510/2) **[-14] =** set value 2 (P510/2) **[-15] =** set value 3 (P510/2) **[-16] =** set value 4 (P510/2) **[-17] =** set value 5 (P510/2)	Setpoint data from the master function value (Broadcast), if P509 = 9/10 (P510 [-02])	
		[-18] = Control word PLC	Control word, source PLC	
		[-19] = set value 1 PLC **[-20] =** set value 2 PLC **[-21] =** set value 3 PLC **[-22] =** set value 4 PLC **[-23] =** set value 5 PLC	Setpoint data from the PLC.	

P741 [-01] ... [-23]	PZD bus Out *(Process data Bus Out)*		S	
0000 ... FFFF (hex)	This parameter provides information about the actual status word and the actual values that are transferred via the bus systems. Standardisation: 8.9 "Scaling of setpoint/actual values "	**[-01] =** Status word	Status word, source from P509.	
		[-02] = Actual value 1 (P543 [-01]) **[-03] =** Actual value 2 (P543 [-02]) **[-04] =** Actual value 3 (P543 [-03]) **[-05] =** Actual value 4 (P543 [-04]) **[-06] =** Actual value 5 (P543 [-05])		
		[-07] = res.status OutBit P481	The displayed value depicts all Bus OUT Bit sources linked with an "*OR*".	
		[-08] = Parameter data Out 1 **[-09] =** Parameter data Out 2 **[-10] =** Parameter data Out 3 **[-11] =** Parameter data Out 4 **[-12] =** Parameter data Out 5	Data during parameter transfer.	
		[-13] = Actual value 1 master function **[-14] =** Actual value 2 master function **[-15] =** Actual value 3 master function **[-16] =** Actual value 4 master function **[-17] =** Actual value 5 master function	Actual value of master function P502 / P503.	
		[-18] = PLC status word	Status word via PLC	
		[-19] = Actual value 1 PLC **[-20]** = Actual value 2 PLC **[-21]** = Actual value 3 PLC **[-22]** = Actual value 4 PLC **[-23]** = Actual value 5 PLC	Actual value data via PLC	

P742	Data base version *(Database version)*		S	
0 ... 9999	Displays the internal database version of the FI.			

P743	Inverter type *(Inverter type)*			
0.00 ... 250.00	Displays the inverter power in kW, e.g. "1.50" ⇒ FI with 1.5 kW nominal power.			

P744	Configuration *(Configuration level)*			
0000 ... FFFF (hex)	This parameter displays the special devices integrated in the FI. Display is in hexadecimal code (SimpleBox, ControlBox, Bus system). The display is in plain text when the ParameterBox is used. **SK 500E … 515E = 0000** **SK 530E … 535E = 0201** **SK 520E = 0101** **SK 540E … 545E = 0301**			

P745	Module version *(Module version)*			
-3276.8 ... 3276.8	Version status (software version) of the technology unit (SK TU3-xxx), but only when own processor is present, i.e. not for SK TU3-CTR. Have this data available if you have a technical query.			

P746	Module status *(Module status)*		S	
0000 ... FFFF (hex)	Shows the actual status (readiness, error, communication) of the technology unit (SK TU3-xxx), but only when own processor is present, i.e. not for SK TU3-CTR. Code details can be found in the respective BUS module manual. Different contents are shown depending on the modules.			

P747	Inverter Volt. Range *(Inverter voltage range)*			
0 ... 3	Indicates the mains voltage range for which this device is specified. **0 =** 100...120V **1 =** 200...240V **2 =** 380...480V **3 =** 400...500V			

P748 [-01] ... [-03]	Status CANopen *(CANopen status)*	SK 520E or higher	S	
0000 ... FFFF (hex)	**[01] =** CANbus/CANopen status Bit 0 = 24V bus voltage supply Bit 1 = CANbus in "Bus Warning" status Bit 2 = CANbus in "Bus Off" status Bit 3 = System bus → Bus module online (field bus module, e.g.: SK xU4-PBR) Bit 4 = System bus → Additional module 1 online (I/O - module, e.g.: SK xU4-IOE) Bit 5 = System bus → Additional module 2 online (I/O - module, e.g.: SK xU4-IOE) Bit 6 = Protocol of the CAN module is 0 = CAN or 1 = CANopen Bit 7 = free Bit 8 = "Bootsup Message" sent Bit 9 = CANopen NMT State Bit 10 = CANopen NMT State Bit 11 ... 15 = free	**[-02] =** reserved	**[-03] =** reserved	

CANopen NMT State	Bit 10	Bit 9
Stopped =	0	0
Pre-Operational =	0	1
Operational =	1	0

P750	Stat. overcurrent *(Overcurrent statistics)*		S	
0 ... 9999	Number of overcurrent messages during the operating period P714.			

P751	Stat. Overvoltage *(Overvoltage statistics))*		S	
0 ... 9999	Number of overvoltage messages during the operating period P714.			

P752	Stat. mains failure *(Mains failure statistics)*		S	
0 ... 9999	Number of mains faults during the operating period P714.			

P753	Stat. overtemperature *(Overheating statistics)*		S	
0 ... 9999	Number of overtemperature faults during the operating period P714.			

P754	**Stat. parameter lost** *(Parameter loss statistics)*		**S**	
0 ... 9999	Number of parameters lost during the operating period P714.			
P755	**Stat. system error** *(System fault statistics)*		**S**	
0 ... 9999	Number of system faults during the operating period P714.			
P756	**Stat. Timeout** *(Time out statistics)*		**S**	
0 ... 9999	Number of Time out errors during the operating period P714.			
P757	**Stat. Customer error** *(Customer fault statistics)*		**S**	
0 ... 9999	Number of Customer Watchdog faults during the operating period P714.			
P799 **[-01]** ... **[-05]**	**Op.-time last error** *(Operating time, last fault 1...5)*			
0.1 ... ___ h	This parameter shows the operating hours counter status (P714) at the moment of the previous fault. Array 01…05 corresponds to the lastest fault 1…5.			

6 Operating status messages

The device and technology units generate appropriate messages if they deviate from their normal operating status. There is a differentiation between warning and error messages. If the device is in the status "Start disabled", the reason for this can also be displayed.

The messages generated for the device are displayed in the corresponding array of parameter (**P700**). The display of the messages for technology units is described in the respective additional instructions and data sheets for the modules concerned.

Start disabled, “Not Ready” → (P700 [-03])

If the device is in the status "Not Ready" or "Start Disabled", the reason for this is indicated in the third array element of parameter (**P700**).

Display is only possible with the NORD CON software or the ParameterBox.

Warning messages → (P700 [-02])

Warning messages are generated as soon as a defined limit is reached. However this does not cause the frequency inverter to switch off. These messages can be displayed via the array-element [**-02**] in parameter (**P700**) until either the reason for the warning is no longer present or the frequency inverter has gone into a fault state with an error message.

Error messages → (P700 [-01])

Errors cause the device to switch off, in order to prevent a device fault.

The following options are available to reset a fault (acknowledge):

- Switching the mains off and on again,
- By an appropriately programmed digital input (**P420**),
- By switching off the “enable” on the device (if no digital input is programmed for acknowledgement),
- By Bus acknowledgement
- By (**P506**), automatic error acknowledgement.

6.1 Display of messages

LED indicators

The device status is indicated by integrated status LEDs that are visible from the outside in delivery state. Depending on the device type, this is either a dual-colour LED (DS = Device State) or two single-colour LEDs (DS = Device State, DE = Device Error).

Meaning:	**Green** indicates operational readiness and the presence of mains voltage. During operation, the degree of overload at the device output is indicated by a faster flashing code. **Red** indicates a pending error. The LED flashes with the frequency corresponding to the error group (for example E003 = 3x flashing).

SimpleBox / ControlBox Display

The SimpleBox / ControlBox displays an error with its number and the prefix "E". In addition, the present fault can be displayed in array element [**-01**] of parameter (**P700**). The last error messages are stored in parameter (**P701**). Further information about the frequency inverter status at the moment of the fault can be obtained from parameters (**P702**) to (**P706**) / (**P799**)

If the cause of the error is no longer present, the error display in the SimpleBox / ControlBox flashes and the error can be acknowledged with the Enter key.

In contrast, warning messages are prefixed with "C" ("**Cxxx**") and cannot be acknowledged. They disappear automatically when the reason for them is no longer present or the frequency inverter has switched to the "Error" state. Display of the message is suppressed if the warning appears during parameterisation.

The present warning message can be displayed in detail at any time in array element [**-02**] of parameter (**P700**).

The reason for an existing disabled switch on cannot be displayed with the SimpleBox / ControlBox.

ParameterBox display

The ParameterBox displays the messages in plain text.

6.2 Messages

Error messages

Display in the SimpleBox / ControlBox		**Fault**	**Cause**
Group	**Details in P700 [-01] / P701**	**Text in the ParameterBox**	• **Remedy**
E001	**1.0**	**Overtemp. Inverter** *"Inverter overtemperature"* (inverter heat sink)	Inverter temperature monitoring measurements are outside of the permissible temperature range, i.e. the error is triggered if the permissible lower limit is undershot or the permissible upper temperature limit is exceeded. • Depending on the cause: Reduce or increase the ambient temperature • Check the FI fan / control cabinet ventilation • Check the FI for dirt
	1.1	**Overtemp. FI internal** *"Internal FI overtemperature"* (interior of FI)	
E002	**2.0**	**Motor overtemp.PTC** *“Motor overtemperature PTC”*	Motor temperature sensor (PTC resistor) has triggered. • Reduce motor load • Increase motor speed • Use external motor fan
	2.1	**Motor overtemp.I²t** *“Motor overtemperature I²t”* Only if I²t motor (P535) has been programmed.	Motor I²t has been triggered (calculated motor overtemperature). • Reduce motor load • Increase motor speed
E003	**3.0**	**Overcurrent I²t-Lim.**	Inverter: I²t limit has triggered, e.g. > 1.5 x I_n for 60 s (also note P504) • Continuous overload at FI output • Possible encoder fault (resolution, defect, connection)
	3.1	**Overcurrent chopper I²t**	Brake chopper: I²t limit has triggered, 1.5 time the value reached for 60 s (also note P554, if available, and P555, P556, P557) • Avoid overcurrent on braking resistor
	3.2	**Overcurrent IGBT** 125% monitoring	De-rating (power reduction) • 220 % Overcurrent • Brake chopper current too high • For fan drives: enable flying start (P520)

	3.3	**Overcurrent IGBTfast** 150% monitoring	De-rating (power reduction) • 230 % Overcurrent • Brake chopper current too high
	3.4	**Overcurrent chopper**	Overcurrent chopper triggering has triggered twice within 50 ms. • Brake chopper current too high • Short circuit, or braking resistance too low
E004	**4.0**	**Overcurrent module**	Error signal from module (short duration) • Short-circuit or earthing fault at FI output • Motor cable is too long • Use external output choke • Brake resistor faulty or resistance too low **→ Do not shut off P537!** **The occurrence of a fault can significantly shorten the service life of the device, or even destroy it.**
	4.1	**Overcurrent measurement** *"Overcurrent measurement"*	P537 (pulse current switch-off) was reached 3x within 50 ms (only possible if P112 and P536 are disabled) • FI is overloaded • Drive sluggish, insufficiently sized • Ramps (P102/P103) too steep -> Increase ramp time • Check motor data (P201 … P209)
E005	**5.0**	**Overvoltage Ud**	Link circuit voltage too high • Increase deceleration time (P103) • Possibly set shutdown mode (P108) with delay (not for lifting equipment) • Extend the quick stop time (P426) • Speed fluctuation (for example due to high inertia loads) → if necessary set the <U/f characteristic curve (P211, P212) FIs with brake chopper: • Dissipate energy feedback with a braking resistor • Check the function of the braking resistor (cable break) • Resistance of connected braking resistor too high
	5.1	**Mains high voltage**	Mains voltage too high • See Technical Data (📖 Section 7)
E006	**6.0**	**Charging fault**	Link circuit voltage too low • Mains voltage too low • See Technical Data (📖 Section 7)
	6.1	**Mains low voltage**	Mains voltage too low • See Technical Data (📖 Section 7)
E007	**7.0**	**Mains Phase Failure**	Error at mains connection side • A mains phase is not connected • Mains asymmetrical
	7.1	**Phasefailure dc-link**	DC link voltage too low • A mains phase is not connected • Load temporarily too high

	On 7.1		**Devices with external 24 V DC supply of the control unit:** If the mains voltage is switched off, but the control unit is still supplied with 24 V DC, this error message also occurs. If the mains voltage is switched on again, the error message must be acknowledged. It is not before until then that the frequency inverter can be enabled.
E008	**8.0**	**Parameter loss** (maximum EEPROM value exceeded)	Error in EEPROM data • Software version of the stored data set is not compatible with the software version of the frequency inverter. **NOTE**: Faulty parameters are automatically reloaded (factory setting). • EMC interferences (see also E020)
	8.1	**Inverter type incorrect**	• EEPROM faulty
	8.2	**External copy error** (ControlBox)	• Check ControlBox for correct position • ControlBox EEPROM defective (**P550 = 1**)
	8.3	**KSE EEPROM error** (Customer unit incorrectly identified (customer unit configuration)	The configuration of the frequency inverter was not correctly identified. • Switch the mains voltage off and on again.
	8.4	**Internal EEPROM error** (Database version incorrect)	
	8.5	**No EEPROM detected**	
	8.6	**EEPR copy used**	
	8.7	**EEPR copy not the same**	
	8.8.	**EEPROM empty**	
	8.9	**EEP. Ctrlbox too small**	• The EEPROM of the ControlBox is too small to save the full frequency inverter data set.
E009	**---**	*Display in ParameterBox not required*	*ControlBox error/ SimpleBox error* SPI Bus faulty, no communication with ControlBox / SimpleBox • Check ControlBox for correct position. • Check correct cabling of SimpleBox. • Switch mains voltage off and on again.
E010	**10.0**	**Bus Timeout**	Telegram time-out / Bus off 24V int. CANbus) Data transfer is faulty. Check P513. • Check external Bus connection. • Check the program sequence of the Bus protocol • Check Bus Master. • Check 24V supply of internal CAN/CANopen Bus. • *Nodeguarding* error (internal CANopen) • *Bus Off* error (internal CANbus)
	10.2	**Bus Timeout Option**	Bus module telegram timeout • Telegram transfer is faulty. • Check external connection. • Check bus protocol program sequence. • Check Bus Master.

	10.4	**Init error Option**	Bus module initialisation failure • Check Bus module power supply. • DIP switch setting of a connected I/O extension module is incorrect • Check P746. • Bus module not correctly plugged in.
	10.1 **10.3** **10.5** **10.6** **10.7**	**System error option**	Bus module system error • Further details can be found in the respective supplementary Bus operating instructions. I/O Extension: • Incorrect measurement of the input voltage or undefined provision of the output voltages due to an error in the reference voltage generation • Short-circuit in analog output
	10.8	**Option error**	External module communication failure • Connection fault / error in the external module • Brief interruption (<1sec) of the 24 V supply of the internal CAN/CANopen bus
	10.9	**Module missing / P120**	The module entered in parameter (P120) is not available. • Check connections
E011	**11.0**	**Customer terminal**	A/D converter error Internal control terminal (internal data bus) incorrect or interference due to radio radiation (EMC). • Check control connections for short circuit. • Minimise EMC interferences by separate routing of control and power cables. • Earth devices and shields well.
E012	**12.0**	**External watchdog**	The Watchdog function is selected at a digital input and the impulse at the corresponding digital input is not present for longer than the time set in parameter P460 >Watchdog time<. • Check connections • Check P460 setting
	12.1	**Motor limit** *"Motor switch-off limit"*	The motor switch-off limit P534 [-01] has triggered. • Reduce load on motor • Set higher value in (P534 [-01]).
	12.2	**Generator limit** *"Generator switch-off limit"*	The generator switch-off limit P534 [-02] has triggered. • Reduce load on motor • Set higher value in (P534 [-02]).
	12.5	**Load limit**	Switch-off due to overshooting or undershooting of permissible load torques ((P525) … (P529)) for the time set in (P528). • Adjust load. • Change limit values ((P525) ... (P527)). • Increase delay time (P528). • Change monitoring mode (P529).
	12.8	**Analog In minimum**	Switch-off due to undershooting of the 0% adjustment value (P402) with setting (P401) "0-10V with switch-off on error 1" or "....2"
	12.9	**Analog In maximum**	Switch-off due to overshooting of the 100% adjustment value (P402) with setting (P401) "0-10V with switch-off on error 1" or "....2"

E013	**13.0**	**Encoder error**	No signal from encoder • If present, check *"Sense"* signal • Check supply voltage of encoder.
	13.1	**Speed slip error** *"Speed slip error"*	The slip speed error limit was reached. • Increase value in **P327** • Increase value in **P328**
	13.2	**Disconnect. control**	The disconnection control is active if: *required deceleration time > 1.5 x Deceleration time (P103) + 2 s* The slip error disconnection control was triggered; the motor could not follow the setpoint. • Check motor data **P201**-**P209**! (important for the current controller) • Check Star Delta connection • Check encoder settings **P300** and following in servo mode • Increase value for torque current limit in **P112** • Increase value for current limit in P536 • Check deceleration time **P103** and extend if necessary
	13.5	**Reserved**	Error message for POSICON → See supplementary instructions
	13.6	**Reserved**	Error message for POSICON → See supplementary instructions
E014	**---**	**Reserved**	Error message for POSICON → see supplementary instructions
E015	**---**	**Reserved**	
E016	**16.0**	**Motor Phase Failure**	A motor phase is not connected. • Check connections and cables on both sides • Check the motor Further notes: • Check **P539**
	16.1	**Magn. Current Watch** *"Magnetisation current monitoring"*	Required exciting current not achieved at moment of switch-on. • Check connections and cables on both sides • Check the motor Further notes: • Check **P539** • Check motor data (**P201 … P209**)
	16.2	**Change phase direct.**	The motor phase sequence (U – V – W) has been changed during operation (enable). Further notes: • Check parameter values in **P583** • Has parameter set (**P100**) been switched over?
E017	**17.0**	**Faulty customer unit**	The frequency inverter does not recognise the customer unit (SK CU5-…). • Check the fastening of the customer unit/contacts EMC faults • Check cable shielding and earth connections of the electrical components
E018	**18.0**	**Reserved**	Error message for "Safe Pulse Block", see supplementary instructions

E019	**19.0**	**Parameter ident.** “Parameter identification”	Automatic identification of the connected motor has failed. • Check motor connection • Check pre-set motor data (P201 … P209)
	19.1	**Rotorposition**	PMSM – CFC closed-loop mode: Rotor position in relation to the incremental encoder is not correct. • Perform a determination of the rotor position (first enable after a “Mains on” only if the motor is at a standstill) (P330)
	19.2	**Rotorpos.North/South**	
E020 E021	**20.0**	**Reserved**	System error in program execution, triggered by EMC interference. • Observe wiring guidelines • Use additional external mains filter. • FI must be very well earthed.
	20.1	**Watchdog**	
	20.2	**Stack overflow**	
	20.3	**Stack underflow**	
	20.4	**Undefined opcode**	
	20.5	**Protected Instruct.** *"Protected Instruction"*	
	20.6	**Illegal word access**	
	20.7	**Illegal Inst. Access** *"Illegal instruction access"*	
	20.8	**Program memory error** "*Program memory error*" (EEPROM error)	
	20.9	**Dual-ported RAM**	
	21.0	**NMI error** (Not used by hardware)	
	21.1	**PLL error**	
	21.2	**ADU error** "Overrun"	
	21.3	**PMI error** "Access Error"	
	21.4	**Userstack overflow**	
E022	**---**	**Reserved**	Error message for PLC → see supplementary instructions BU 0550
E023	**---**	**Reserved**	Error message for PLC → see supplementary instructions BU 0550
E024	**---**	**Reserved**	Error message for PLC → see supplementary instructions BU 0550
E025	**---**	**Reserved**	Error message for POSICON → see supplementary instructions

Warning messages

Display in the SimpleBox / ControlBox		Warning Text in the ParameterBox	Cause • Remedy
Group	**Details in P700 [-02]**		
C001	**1.0**	**Overtemp. Inverter** *"Inverter overtemperature"* (inverter heat sink)	Inverter temperature monitoring Warning: permissible temperature limit reached. • Reduce ambient temperature • Check the FI fan / control cabinet ventilation • Check the FI for dirt
C002	**2.0**	**Motor overtemp.PTC** *"Motor overtemperature PTC"*	Warning from the PTC resistor (trigger limit reached) • Reduce motor load • Increase motor speed • Use external motor fan
	2.1	**Motor overtemp.I²t** *"Motor overtemperature I²t"* Only if I²t motor (P535) is programmed.	Warning: I²t motor monitoring (1.3 x the rated current reached for the time period set in (P535)) • Reduce motor load • Increase motor speed
	2.2	**Ext Resistor Temp** *"External braking resistor overtemperature"* Overtemperature via digital input (P420 […]) = {13}	Warning: Temperature sensor (e.g. braking resistor) has triggered • Digital input is low
C003	**3.0**	**Overcurrent, I²t limit**	Warning: Inverter: I²t limit has triggered, e.g. > 1.3 x I_n for 60s (please also note P504) • Continuous overload at FI output
	3.1	**Overcurrent, chopper I²t**	Warning: I²t limit for the brake chopper has triggered, 1.3x value attained for 60s (also note P554, if present, as well as P555, P556, P557) • Avoid overload of brake resistance
	3.5	**Torque current limit**	Warning: Torque current limit reached • Check (P112)
	3.6	**Current limit**	Warning: Current limit reached • Check (P536)
C004	**4.1**	**Overcurrent measurement** *"Overcurrent measurement"*	Warning: pulse switch off is active The limit for activation of pulse switch off (P537) has been reached (only possible if P112 and P536 are switched off) • FI is overloaded • Drive sluggish, insufficiently sized • Ramps (P102/P103) too steep -> Increase ramp time • Check motor data (P201 … P209) • Switch off slip compensation (P212)

C008	**8.0**	**Parameter loss**	Warning: One of the cyclically saved messages such as *operating hours* or *enabling time* could not be saved successfully. The warning disappears as soon as saving can be successfully performed.
C012	**12.1**	**Motor Limit / Customer** *"Motor switch-off limit"*	Warning: 80 % of the drive switch-off limit (P534 [-01]) has been exceeded. • Reduce load on motor • Set higher value in (P534 [-01]).
	12.2	**Generator limit** *"Generator switch-off limit"*	Warning: 80 % of the generator switch-off limit (P534 [-02]) has been reached. • Reduce load on motor • Set higher value in (P534 [-02]).
	12.5	**Load monitor**	Warning due to overshooting or undershooting of permissible load torques ((P525) … (P529)) for the time set in (P528). • Adjust load. • Change limit values ((P525) ... (P527)). • Increase delay time (P528).

Switch-on block messages

Display in the SimpleBox / ControlBox		Reason: Text in the ParameterBox	Cause • Remedy
Group	**Details in P700 [-03]**		
I000	**0.1**	**Disable voltage from IO**	If the function "disable voltage"is parameterised, input (P420 / P480) is at Low • Set "input High" • Check signal cable (broken cable)
	0.2	**IO fast stop**	If the function "fast stop"is parameterised, input (P420 / P480) is at Low • Set "input High" • Check signal cable (broken cable)
	0.3	**Block voltage from bus**	• For bus operation (P509): control word Bit 1 is "Low"
	0.4	**Bus fast stop**	• For bus operation (P509): control word Bit 2 is "Low"
	0.5	**Enable on start**	Enable signal (control word, Dig I/O or Bus I/O) was already applied during the initialisation phase (after mains "ON", or control voltage "ON"). Or electrical phase is missing. • Only issue enable signal after completion of initialisation (i.e. when the FI is ready) • Activation of "Automatic Start" (P428)
	0.6 – 0.7	**Reserved**	Information message for PLC → see supplementary instructions
	0.8	**Right direction blocked**	Switch-on block with inverter shut-off activated by: **P540** or by "Enable right block" (**P420** = 31, 73) or "Enable left block" (**P420** = 32, 74), The frequency inverter switches to "Ready for switching on" status
	0.9	**Left direction blocked**	
I006 [1]	**6.0**	**Charging error**	Charging relay not energised, because: • Mains / link voltage too low • Mains failure • Evacuation run activated ((P420) / (P480))
I011	**11.0**	**Analog Stop**	If an analog input of the frequency inverter or a connected IO extension is configured to detect cable breaks (2-10V signal or 4-20mA signal), the frequency inverter switches to the status "ready for switch-on" if the analog signal undershoots the value **1 V** or **2 mA** This also occurs if the relevant analog input is parameterised to function "0" ("no function"). • Check connections
I014 [1]	**14.4**	**Reserved**	Error message for POSICON → see supplementary instructions
I018 [1]	**18.0**	**Reserved**	Information message for "Safe Stop" function → see supplementary instructions

1) Indication of operating mode (message) on the *ParameterBox* or virtual operating unit of the *NORD CON-Software*: **"Not ready"**

7 Technical data

7.1 General frequency inverter data

Function	Specification	
Output frequency	0 ... 400 Hz	
Pulse frequency	3 ... 16 kHz, default setting = 6 kHz (size 8 and higher = 4 kHz) Power reduction > 8 kHz for 230 V device, > 6 kHz for 400 V device	
Typical overload capacity	150% for 60 s, 200% for 3.5 s	
Efficiency	Sizes 1 … 4: approx. 95%; size 5 … 7: approx. 97%; size 8 and higher: approx. 98%	
Energy efficiency	IE2 (for details, see Chapter 7.2)	
Insulation resistance	> 5 MΩ	
Leakage current	• Height depends on the configuration of the integrated line filter (for details, see Chapter 2.9.2) • The specifications apply to the factory setting of the pulse frequency (see also parameter P504)	
Ambient temperature	0 °C ... +40 °C (S1-100% ED); for detailed information (including UL values) on the individual device types and operating modes, see Chapter 7.3.	
Storage and transport temperature	-20 °C ... +60/70 °C	
Long-term storage	(chapter 9.1)	
Protection class	IP20	
Max. installation altitude above sea level	• Up to 1000 m: • 1000 ... 4000 m: – Up to 2000 m: – Up to 4000 m:	No power reduction 1%/100 m power reduction Overvoltage category 3 Overvoltage category 2, mains input: overvoltage protection required
Ambient conditions	Transport (IEC 60721-3-2): Operation (IEC 60721-3-3):	Mechanical: 2M1 Mechanical: 3M4; climatic: 3K3
Waiting period between 2x “Mains on”	60 s for all devices in normal operating cycle	
Protective measures against	Overtemperature of the frequency inverter Overvoltage and undervoltage	Short circuit, earth fault Overload
Regulation and control	Sensorless current vector control (ISD), linear V/f characteristic curve, VFC open-loop, CFC open-loop, CFC closed-loop (SK 520E and higher)	
Motor temperature monitoring	I^2t motor, PTC/bimetallic switch	
Interfaces (integrated)	RS 485 (USS) RS 232 (single slave) Modbus RTU	CANbus (except SK 50xE) CANopen (except SK 50xE)
Electrical isolation	Control terminals (digital and analogue inputs)	
Connection terminals	Details and tightening torques of screw terminals: see (chapter 2.9.4)and (chapter 2.9.5)	
External supply voltage SK 5x5E control unit	Sizes 1 … 4: Sizes 5 … 7: Sizes 8 … 11:	18 … 30 V DC, ≥ 800 mA 24 … 30 V DC, ≥ 1000 mA 24 … 30 V DC, ≥ 3000 mA
Analogue setpoint input / PID input	2x (size 5 and higher: -10 V …) 0 ... 10 V, 0/4 ... 20 mA, scalable, digital 7.5 ... 30 V	
Analogue setpoint resolution	10 bit based on measurement range	
Setpoint consistency	Analogue < 1%, digital < 0.02%	
Digital input	5x (2.5 V) 7.5 ... 30 V, R_i = (2.2 kΩ) 6.1 kΩ, cycle time = 1 ... 2 ms + SK 520E and higher: 2x 7.5 ... 30 V, R_i = 6.1 kΩ, cycle time = 1 ... 2 ms	

Function	Specification
Control outputs	2x relay 28 V DC / 230 V AC, 2 A (output 1/2 – K1/K2)
	Additionally for SK 520E/530E/540E: 2x DOUT 15 V, 20 mA or Additionally for SK 535E/545E: 2x DOUT 18 … 30 V (depending on VI), 20 mA or 2x DOUT 18 … 30 V, 200 mA for size 5 and higher (Output 3/4 – DOUT1/2)
Analogue output	0 ... 10 V, scalable

7.2 Technical data for determining the energy efficiency level

The following tables relate to the provisions of the Ecodesign EU Regulation 2019/1781.

Information

Calculation basis for the energy efficiency level

The energy efficiency specifications come from calculations according to **DIN EN 61800** *"Adjustable speed electrical power drive systems – Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Energy efficiency indicators for power drive systems and motor starters"*.

Simplifications are included in the calculation methods of the standard!

Manufact	FI type	Rel. losses [1] (rel. motor stator frequency / rel. torque-producing current)								Standby [2]	Standby [2] (UKCA)	IE rating
		90/100	90/50	50/100	50/50	50/25	0/100	0/50	0/25			
Getriebebau NORD GmbH & Co. KG	NORDAC *PRO* SK 5xxE-	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[W]	[%]	
	250-323	4,8	4,1	4,3	3,9	3,8	4,0	3,7	3,7	6,2	2,46	IE2
	370-323	4,1	3,3	3,6	3,2	3,1	3,3	3,0	3,0	6,2	1,68	IE2
	550-323	3,6	2,8	3,2	2,7	2,6	2,9	2,5	2,5	6,2	1,12	IE2
	750-323	3,4	2,6	2,9	2,4	2,3	2,6	2,2	2,2	6,2	0,82	IE2
	111-323	3,1	2,1	2,6	1,9	1,6	2,2	1,8	1,6	6,5	0,59	IE2
	151-323	3,1	2,1	2,6	1,9	1,6	2,2	1,7	1,5	6,5	0,43	IE2
	221-323	3,2	2,1	2,7	1,9	1,6	2,4	1,8	1,6	6,5	0,29	IE2
	301-323	3,0	2,0	2,5	1,8	1,5	2,2	1,6	1,4	6,9	0,23	IE2
	401-323	3,0	1,9	2,4	1,7	1,3	2,1	1,5	1,3	6,9	0,17	IE2
	551-323	3,9	2,6	3,4	2,4	2,1	3,0	2,3	2,0	21,0	0,38	IE2
	751-323	3,7	2,1	3,1	1,9	1,5	2,7	1,8	1,4	21,0	0,28	IE2
	112-323	3,8	2,1	3,2	1,9	1,5	2,8	1,8	1,4	17,4	0,16	IE2
	152-323	3,3	1,7	2,6	1,5	1,1	2,1	1,3	1,0	26,0	0,17	IE2
	182-323	3,4	1,8	2,8	1,6	1,2	2,3	1,4	1,1	26,0	0,14	IE2
	550-340	4,0	3,6	3,9	3,5	3,4	3,7	3,4	3,4	8,5	1,54	IE2
	750-340	3,6	2,8	3,4	2,8	2,5	3,2	2,7	2,5	8,5	1,13	IE2
	111-340	3,2	2,4	3,0	2,4	2,1	2,8	2,3	2,1	8,9	0,81	IE2
	151-340	3,0	2,2	2,8	2,2	1,9	2,7	2,1	1,8	8,9	0,59	IE2
	221-340	2,9	2,0	2,7	1,9	1,6	2,5	1,8	1,6	8,9	0,41	IE2
	301-340	2,9	2,0	2,7	1,9	1,6	2,5	1,8	1,6	10,6	0,35	IE2
	401-340	2,9	1,9	2,6	1,8	1,5	2,4	1,7	1,5	10,6	0,26	IE2
	551-340	2,5	1,4	2,2	1,3	1,0	2,0	1,2	1,0	9,8	0,18	IE2
	751-340	2,4	1,3	2,1	1,2	0,9	1,9	1,1	0,9	11,8	0,16	IE2
	112-340	2,7	1,7	2,5	1,6	1,3	2,3	1,5	1,2	24,9	0,23	IE2
	152-340	2,6	1,5	2,3	1,4	1,1	2,1	1,3	1,1	25,5	0,17	IE2
	182-340	2,7	1,6	2,4	1,5	1,2	2,2	1,4	1,1	24,6	0,13	IE2
	222-340	2,7	1,5	2,4	1,4	1,1	2,1	1,3	1,1	24,6	0,11	IE2
	302-340	2,3	1,3	2,0	1,2	0,9	1,9	1,1	0,9	30,7	0,10	IE2
	372-340	2,6	1,5	2,3	1,4	1,0	2,1	1,3	1,0	30,7	0,08	IE2
	452-340	1,8	0,9	1,5	0,8	0,6	1,4	0,8	0,6	21,1	0,05	IE2
	552-340	1,8	0,9	1,6	0,8	0,6	1,4	0,7	0,5	21,1	0,04	IE2
	752-340	2,0	1,0	1,7	0,9	0,6	1,5	0,8	0,6	25,2	0,03	IE2
	902-340	2,1	1,0	1,7	0,9	0,6	1,5	0,8	0,6	25,2	0,03	IE2
	113-340	1,7	0,9	1,4	0,8	0,5	1,2	0,7	0,5	47,3	0,04	IE2
	133-340	1,9	1,0	1,6	0,9	0,6	1,4	0,8	0,6	48,1	0,04	IE2
	163-340	2,0	1,0	1,7	0,9	0,6	1,4	0,8	0,6	49,8	0,03	IE2
	203-340	2,1	1,0	1,7	0,9	0,6	1,4	0,7	0,5	60,5	0,03	IE2

1) Power losses in % of the rated apparent output power

2) Standby losses in % of the rated output power

Manuf	FI type	Output power	Indicative output power	Rated output current	Max. operating temperature	Rated input frequency	Rated input voltage range
	NORDAC *PRO* SK 5xxE-	**[kVA]**	**[kW]**	**[A]**	**[°C]**	**[Hz]**	**[V]**
Getriebebau NORD GmbH & Co. KG	250-323	0,5	0,25	1,3	40	50	200 V – 240 V
	370-323	0,7	0,37	1,8	40	50	200 V – 240 V
	550-323	1,0	0,55	2,6	40	50	200 V – 240 V
	750-323	1,3	0,75	3,4	40	50	200 V – 240 V
	111-323	1,7	1,10	4,5	40	50	200 V – 240 V
	151-323	2,3	1,50	6,0	40	50	200 V – 240 V
	221-323	3,3	2,20	8,7	40	50	200 V – 240 V
	301-323	4,4	3,00	11,7	40	50	200 V – 240 V
	401-323	5,9	4,00	15,3	40	50	200 V – 240 V
	551-323	7,9	5,50	20,8	40	50	200 V – 240 V
	751-323	10,0	7,50	26,1	40	50	200 V – 240 V
	112-323	14,4	11,0	37,8	40	50	200 V – 240 V
	152-323	19,5	15,0	51,1	40	50	200 V – 240 V
	182-323	23,9	18,5	62,6	40	50	200 V – 240 V
	550-340	1,2	0,55	1,7	40	50	380 V – 480 V
	750-340	1,6	0,75	2,3	40	50	380 V – 480 V
	111-340	2,1	1,10	3,1	40	50	380 V – 480 V
	151-340	2,8	1,50	4,0	40	50	380 V – 480 V
	221-340	3,8	2,20	5,5	40	50	380 V – 480 V
	301-340	5,2	3,00	7,5	40	50	380 V – 480 V
	401-340	6,6	4,00	9,5	40	50	380 V – 480 V
	551-340	8,7	5,50	12,5	40	50	380 V – 480 V
	751-340	11,1	7,50	16,0	40	50	380 V – 480 V
	112-340	16,6	11,0	24,0	40	50	380 V – 480 V
	152-340	21,5	15,0	31,0	40	50	380 V – 480 V
	182-340	26,3	18,5	38,0	40	50	380 V – 480 V
	222-340	31,9	22,0	46,0	40	50	380 V – 480 V
	302-340	41,6	30,0	60,0	40	50	380 V – 480 V
	372-340	52,0	37,0	75,0	40	50	380 V – 480 V
	452-340	62,4	45,0	90,0	40	50	380 V – 480 V
	552-340	76,2	55,0	110,0	40	50	380 V – 480 V
	752-340	103,9	75,0	150,0	40	50	380 V – 480 V
	902-340	124,7	90,0	180,0	40	50	380 V – 480 V
	113-340	135,4	110,0	205,6	40	50	380 V – 480 V
	133-340	162,1	132,0	246,3	40	50	380 V – 480 V
	163-340	196,0	160,0	297,9	40	50	380 V – 480 V
	203-340	244,5	200,0	371,5	40	50	380 V – 480 V

7.3 Electrical data

The following tables contain the data which is relevant for UL

Details of UL- / CSA approval conditions can be found in Section 1.7.1. Use of mains fuses which are faster than those stated is permissible.

By use of a mains choke, the input current is reduced to approximately the value of the output current 2.7.1 "Mains chokes".

7.3.1 Electrical data 115 V

Device type		**SK 5xxE…**	**-250-112-**	**-370-112-**	**-550-112-**	**-750-112-**	**-111-112-**
		Size	**1**	**1**	**1**	**1**	**1**
Nominal motor power (4-pole standard motor)		230 V	0.25 kW	0.37 kW	0.55 kW	0.75 kW	1.10 kW
		240 V	1/3 hp	½ hp	¾ hp	1 hp	1 ½ hp
Mains voltage		**115 V**	**1 AC**, 100 … 120 V, ± 10%, 47 … 63 Hz				
Input current		rms	8.9 A	11.0 A	13.1 A	20.1 A	23.5 A
		FLA	8.9 A	10.8 A	13.1 A	20.1 A	23.5 A
Output voltage		**230 V**	3 AC, 0 … 2x mains voltage				
Output current		rms	1.7 A	2.2 A	3.0 A	4.0 A	5.3 A
		FLA	1.7 A	2.1 A	3.0 A	4.0 A	5.3 A
Min. braking resistance		Accessories	240 Ω	190 Ω	140 Ω	100 Ω	75 Ω
Pulse frequency		Range	3 … 16 kHz				
		Factory setting	6 kHz				
Ambient temperature		S1	40 °C	40 °C	40 °C	40 °C	40 °C
		S3 80%, 10 min.	50 °C	50 °C	50 °C	50 °C	50 °C
		S3 70%, 10 min.	50 °C	50 °C	50 °C	50 °C	50 °C
Type of ventilation			Free convection				
			General fuses (AC) (recommended)				
		Slow-blowing	10 A	16 A	16 A	25 A	25 A
		Isc [1] [A]	**Fuses (AC), UL-approved**				
		5 000					
		10 000					
		100 000					
		Class					
Fuse	J (600 V)	x	10 A	13 A	20 A	25 A	25 A
Fuse	CC, J, R, T, G, L (300 V)	x	10 A	20 A	20 A	25 A	20 A
Fuse	Bussmann **LPJ-**	x	**10SP**	**13SP**	**20SP**	**25SP**	**25SP**
CB	(480 V)	x	15 A	15 A	20 A	25 A	20 A

1) Maximum permissible mains short-circuit current

7.3.2 Electrical data 230 V

Note: Fields with two values (separated by a dash) are to be interpreted as follows:

1. The first value applies to single-phase mains connection
2. The second value applies to three-phase mains connection

Device type		**SK 5xxE…**	**-250-323-**	**-370-323-**	**-550-323-**	**-750-323-**	
		Size	**1**	**1**	**1**	**1**	
Nominal motor power (4-pole standard motor)		230 V	0.25 kW	0.37 kW	0.55 kW	0.75 kW	
		240 V	1/3 hp	½ hp	¾ hp	1 hp	
Mains voltage		230 V	1 / 3 AC, 200 … 240 V, ± 10%, 47 … 63 Hz				
Input current		rms	3.7 / 2.4 A	4.8 / 3.1 A	6.5 / 4.2 A	8.7 / 5.6 A	
		FLA	3.7 / 2.4 A	4.8 / 3.1 A	6.5 / 4.2 A	8.7 / 5.6 A	
Output voltage		230 V	3 AC 0 – Mains voltage				
Output current		rms	1.7 A	2.2 A	3.0 A	4.0 A	
		FLA	1.7 A	2.2 A	2.9 A	3.9 A	
Min. braking resistance		Accessories	240 Ω	190 Ω	140 Ω	100 Ω	
Pulse frequency		Range	3 … 16 kHz				
		Factory setting	6 kHz				
Ambient temperature[1]		S1	40 °C	40 °C	40 °C	40 °C	
		S3 80%, 10 min.	50 °C	50 °C	50 °C	50 °C	
		S3 70%, 10 min.	50 °C	50 °C	50 °C	50 °C	
Type of ventilation			Free convection				
			General fuses (AC) (recommended)				
Slow-blowing			6 / 6 A	6 / 6 A	10 / 6 A	10 / 6 A	
		Isc [2] [A]	**Fuses (AC), UL-approved**				
	Class	5 000 / 10 000 / 100 000					
Fuse	J (600 V)	x	4 / 2.5 A	5 / 3.2 A	7 / 4.5 A	9 / 6 A	
Fuse	CC, J, R, T, G, L (300 V)	x	6 / 6 A	6 / 6 A	10 / 10 A	25 / 10 A	
Fuse	Bussmann **LPJ-**	x	**4SP / 2.5SP**	**5SP / 3.2SP**	**7SP / 4.5SP**	**9SP / 6SP**	
CB	(480 V)	x	5 / 5 A	5 / 5 A	10 / 10 A	10 / 10 A	

1) When using safe functions (STO and SS1), restrictions regarding the permissible temperature range according to BU 0530 must be noted.

2) Maximum permissible mains short-circuit current

Note: Fields with two values (separated by a dash) are to be interpreted as follows:

- The first value applies to single-phase mains connection
- The second value applies to three-phase mains connection

Device type		**SK 5xxE…**	**-111-323-**	**-151-323-**	**-221-323-**	**-301-323-**	**-401-323-**
		Size	**2**	**2**	**2**	**3**	**3**
Nominal motor power (4-pole standard motor)		230 V	1.1 kW	1.5 kW	2.2 kW	3.0 kW	4.0 kW
		240 V	1½ hp	2 hp	3 hp	4 hp	5 hp
Mains voltage		230 V	1 / 3 AC 200 … 240 V, ± 10%, 47 … 63 Hz			3 AC	
Input current		rms	12.0 / 7.7 A	15.2 / 9.8 A	19.6 / 13.3 A	17.5 A	22.4 A
		FLA	12.0 / 7.7 A	15.2 / 9.8 A	19.6 / 13.3 A	17.5 A	22.4 A
Output voltage		230 V	3 AC 0 – Mains voltage				
Output current		rms	5.5 A	7.0 A	9.5 A	12.5 A	16.0 A
		FLA	5.4 A	6.9 A	8.8 / 9.3 A	12.3 A	15.7 A
Min. braking resistance		Accessories	75 Ω	62 Ω	46 Ω	35 Ω	26 Ω
Pulse frequency		Range	3 … 16 kHz				
		Factory setting	6 kHz				
Ambient temperature[1]		S1	40 °C	40 °C	40 °C	40 °C	40 °C
		S3 80%, 10 min.	50 °C	50 °C	50 °C	-	-
		S3 70%, 10 min.	50 °C	50 °C	50 °C	50 °C	50 °C
Type of ventilation			Fan cooling, temperature-controlled switching thresholds: [2] ON = 57 °C, OFF = 47 °C				
			General fuses (AC) (recommended)				
Slow-blowing			16 A / 10 A	16 A / 10 A	20 A / 16 A	20 A	25 A
		Isc [3] [A]	**Fuses (AC), UL-approved**				
	Class	5 000 / 10 000 / 100 000					
Fuse	J (600 V)	x	13 / 8 A	17.5 / 10 A	20 / 15 A	17.5 A	25 A
Fuse	CC, J, R, T, G, L (300 V)	100 000	30 / 10 A	30 / 20 A	30 / 30 A	30 A	30 A
Fuse	Bussmann **LPJ-**	x	**13SP / 8SP**	**17.5SP / 10SP**	**20SP / 15SP**	**17.5SP**	**25SP**
CB	(480 V)	10 000	25 / 10 A	25 A	25 A	25 A	25 A

1) When using safe functions (STO and SS1), restrictions regarding the permissible temperature range according to BU 0530 must be noted.

2) Short test run after connection of the mains voltage (SK 5x5 devices: after connection of the control voltage)

3) Maximum permissible mains short-circuit current

Device type		SK 5xxE…	-551-323-	-751-323-	-112-323-	-152-323-	-182-323-
		Size	5	5	6	7	7
Nominal motor power (4-pole standard motor)		230 V	5.5 kW	7.5 kW	11.0 kW	15.0 kW	18.5 kW
		240 V	7½ hp	10 hp	15 hp	20 hp	25 hp
Mains voltage		230 V	3 AC 200 … 240 V, ± 10%, 47 … 63 Hz				
Input current		rms	30.8 A	39.2 A	64.4 A	84.0 A	102 A
		FLA	30.8 A	39.2 A	58.8 A	66.6 A	83.8 A
Output voltage		230 V	3 AC 0 – Mains voltage				
Output current		rms	22.0 A	28.0 A	46.0 A	60.0 A	73.0 A
		FLA	22 A	28 A	42 A	54 A	68 A
Min. braking resistance		Accessories	19 Ω	14 Ω	10 Ω	7 Ω	6 Ω
Pulse frequency		Range	3 … 16 kHz				
		Factory setting	6 kHz				
Ambient temperature[1]		S1	40 °C	40 °C	40 °C	40 °C	40 °C
		S3 80%, 10 min.	-	-	-	-	-
		S3 70%, 10 min.	-	-	-	-	-
Type of ventilation			Fan cooling, temperature-controlled switching thresholds: [2] ON = 57 °C, OFF = 47 °C				
			General fuses (AC) (recommended)				
Slow-blowing			35 A	40 A	80 A	100 A	125 A
		Isc [3] [A]	**Fuses (AC), UL-approved**				
	Class	5 000 / 65 000 / 100 000					
Fuse	(600 V)	x	30 A [4]	40 A [4]	60 A [4]	-	-
	CC, J, R, T (240 V)	x	30 A [4]	40 A [4]	60 A [4]	-	-
	CC, J, R, T, G, L (300 V)	x	-	-	-	100 A	100 A
	Bussmann **LPJ-**	x x	**30SP**	**40SP**	**60SP**	**-**	**-**
CB	(240 V)	x	60 A [4]	60 A [4]	60 A [4]	-	-
	(480 V)	x	60 A [4]	60 A [4]	60 A [4]	-	-
	(480 V)	x				100 A	100 A

1) When using safe functions (STO and SS1), restrictions regarding the permissible temperature range according to BU 0530 must be noted.

2) Short test run after connection of the mains voltage or control voltage

3) Maximum permissible mains short-circuit current

4) Suitable for mains voltage

7.3.3 Electrical data 400 V

Device type	SK 5xxE…	-550-340-	-750-340-	-111-340-	-151-340-	-221-340-
	Size	**1**	**1**	**2**	**2**	**2**
Nominal motor power (4-pole standard motor)	400 V	0.55 kW	0.75 kW	1.1 kW	1.5 kW	2.2 kW
	480 V	¾ hp	1 hp	1½ hp	2 hp	3 hp
Mains voltage	**400 V**	**3 AC** 380 … 480 V, -20% / +10%, 47 … 63 Hz				
Input current	rms	2.4 A	3.2 A	4.3 A	5.6 A	7.7 A
	FLA	2.4 A	3.2 A	4.3 A	5.6 A	7.7 A
Output voltage	**400 V**	3 AC 0 – Mains voltage				
Output current	rms	1.7 A	2.3 A	3.1 A	4.0 A	5.5 A
	FLA	1.5 A	2.1 A	2.8 A	3.6 A	4.9 A
Min. braking resistance	Accessories	390 Ω	300 Ω	220 Ω	180 Ω	130 Ω
Pulse frequency	Range	3 … 16 kHz				
	Factory setting	6 kHz				
Ambient temperature[1]	S1	40 °C	40 °C	40 °C	40 °C	40 °C
	S3 80%, 10 min	50 °C	50 °C	50 °C	50 °C	50 °C
	S3 70%, 10 min	50 °C	50 °C	50 °C	50 °C	50 °C
Type of ventilation		Free convection			Fan cooling, temperature-controlled switching thresholds: [2] ON = 57 °C, OFF = 47 °C	
		General fuses (AC) (recommended)				
	Slow-blowing	6 A	6 A	6 A	6 A	10 A

	Class	Isc [3] [A] 5 000	10 000	100 000	Fuses (AC), UL-approved				
Fuse	J (600 V)	x			2.5 A	3.5 A	4.5 A	6 A	8 A
	CC, J, R, T, G, L (600 V)			x	6 A	6 A	10 A	10 A	10 A
	Bussmann **LPJ-**	x			**2.5SP**	**3.5SP**	**4.5SP**	**6SP**	**8SP**
CB	(480 V)		x		5 A	5 A	10 A	10 A	10 A

1) When using safe functions (STO and SS1), restrictions regarding the permissible temperature range according to BU 0530 must be noted.

2) Short test run after connection of the mains voltage (SK 5x5 devices: after connection of the control voltage)

3) Maximum permissible mains short-circuit current

Device type	SK 5xxE…	-301-340-	-401-340-	-551-340-	-751-340-	
	Size	**3**	**3**	**4**	**4**	
Nominal motor power (4-pole standard motor)	400 V	3.0 kW	4.0 kW	5.5 kW	7.5 kW	
	480 V	4 hp	5 hp	7½ hp	10 hp	
Mains voltage	400 V	3 AC 380 … 480 V, -20% / +10%, 47 … 63 Hz				
Input current	rms	10.5 A	13.3 A	17.5 A	22.4 A	
	FLA	10.5 A	13.3 A	17.5 A	22.4 A	
Output voltage	400 V	3 AC 0 – Mains voltage				
Output current	rms	7.5 A	9.5 A	12.5 A	16 A	
	FLA	6.7 A	8.5 A	11 A	14 A	
Min. braking resistance	Accessories	91 Ω	74 Ω	60 Ω	44 Ω	
Pulse frequency	Range	3 … 16 kHz				
	Factory setting	6 kHz				
Ambient temperature[1]	S1	40 °C	40 °C	40 °C	40 °C	
	S3 80%, 10 min.	-	-	50 °C	50 °C	
	S3 70%, 10 min.	50 °C	50 °C	50 °C	50 °C	
Type of ventilation		Fan cooling, temperature-controlled switching thresholds: [2] ON = 57 °C, OFF = 47 °C				
		General fuses (AC) (recommended)				
Slow-blowing		16 A	16 A	20 A	25 A	

	Class	Isc [3] [A] 5 000	10 000	100 000	**Fuses (AC), UL-approved**				
Fuse	J (600 V)	x			12 A	15 A	20 A	25 A	
Fuse	CC, J, R, T, G, L (600 V)			x	25 A	30 A	30 A	30 A	
Fuse	Bussmann **LPJ-**	x			**12SP**	**15SP**	**20SP**	**25SP**	
CB	(480 V)		x		25 A	25 A	25 A	25 A	

1) When using safe functions (STO and SS1), restrictions regarding the permissible temperature range according to BU 0530 must be noted.

2) Short test run after connection of the mains voltage (SK 5x5 devices: after connection of the control voltage)

3) Maximum permissible mains short-circuit current

Device type	SK 5xxE…	-112-340-	-152-340-	-182-340-	-222-340-	
	Size	**5**	**5**	**6**	**6**	
Nominal motor power (4-pole standard motor)	400 V	11.0 kW	15.0 kW	18.5 kW	22.0 kW	
	480 V	15 hp	20 hp	25 hp	30 hp	
Mains voltage	**400 V**	**3 AC** 380 … 480 V, -20% / +10%, 47 … 63 Hz				
Input current	rms	33.6 A	43.4 A	53.2 A	64.4 A	
	FLA	29.4 A	37.8 A	47.6 A	56 A	
Output voltage	**400 V**	3 AC 0 – Mains voltage				
Output current	rms	24 A	31 A	38 A	46 A	
	FLA	21 A	27 A	34 A	40 A	
Min. braking resistance	Accessories	29 Ω	23 Ω	18 Ω	15 Ω	
Pulse frequency	Range	3 … 16 kHz				
	Factory setting	6 kHz				
Ambient temperature[1]	S1	40 °C	40 °C	40 °C	40 °C	
	S3 80%, 10 min.	-	-	-	-	
	S3 70%, 10 min.	-	-	-	-	
Type of ventilation		Fan cooling, temperature-controlled switching thresholds: [2] ON = 57 °C, OFF = 47 °C				
		General fuses (AC) (recommended)				
	Slow-blowing	35 A	50 A	63 A	80 A	

	Class	Isc [3] [A] 5 000	65 000	100 000	**Fuses (AC), UL-approved**				
Fuse	(480 V)	x			40 A [4]	50 A [4]	60 A [4]	60 A [4]	
Fuse	CC, J, R, T (480 V)		x		40 A [4]	50 A [4]	60 A [4]	60 A [4]	
Fuse	Bussmann **LPJ-**	x	x		**30SP**	**40SP**	**60SP**	**60SP**	
CB	(480 V)	x	x		60 A [4]	60 A [4]	60 A [4]	60 A [4]	

1) When using safe functions (STO and SS1), restrictions regarding the permissible temperature range according to BU 0530 must be noted.

2) Short test run after connection of the mains voltage or control voltage

3) Maximum permissible mains short-circuit current

4) Suitable for mains voltage

Device type	**SK 5xxE…**	**-302-340-**	**-372-340-**	**-452-340-**	**-552-340-**	**-752-340-**
	Size	**7**	**7**	**8**	**8**	**9**
Nominal motor power (4-pole standard motor)	400 V	30.0 kW	37.0 kW	45.0 kW	55.0 kW	75.0 kW
	480 V	40 hp	50 hp	60 hp	75 hp	100 hp
Mains voltage	**400 V**	**3 AC** 380 … 480 V, -20% / +10%, 47 … 63 Hz				
Input current	rms	84 A	105 A	126 A	154 A	210 A
	FLA	64.1 A	80 A	108 A	134 A	174 A
Output voltage	**400 V**	3 AC 0 – Mains voltage				
Output current	rms	60 A	75 A	90 A	110 A	150 A
	FLA	52 A	68 A	77 A	96 A	124 A
Min. braking resistance	Accessories	9 Ω	9 Ω	8 Ω	8 Ω	6 Ω
Pulse frequency	Range	3 … 16 kHz		3 … 8 kHz		
	Factory setting	6 kHz		4 kHz		
Ambient temperature[1]	S1	40 °C	40 °C	40 °C	40 °C	40 °C
	S3 80%, 10 min.	-	-	-	-	-
	S3 70%, 10 min.	-	-	-	-	-
Type of ventilation		Fan cooling, temperature-controlled switching thresholds: [2] ON = 57 °C, OFF = 47 °C		ON = 56 °C, OFF = 52 °C		
Fan (blower) speed control		Between 47 °C (52 °C) and approx. 70 °C[3]				
		General fuses (AC) (recommended)				
Slow-blowing		100 A	125 A	160 A	160 A	224 A

	Class	Isc [4] [A] 10 000	65 000	100 000	**Fuses (AC), UL-approved**				
Fuse	RK5 (480 V)	x			-	-	125 A	150 A	200 A
	CC, J, R, T, G, L (600 V)			x	100 A	100 A	125 A	150 A	200 A
CB	(480 V)	x	x		-	-	125 A	150 A	200 A
	(480 V)		x		100 A	100 A	-	-	-

1) When using safe functions (STO and SS1), restrictions regarding the permissible temperature range according to BU 0530 must be noted.

2) Short test run after connection of the mains voltage or control voltage

3) In case of frequency inverter overload, the fan speed is increased to 100% – regardless of the actual device temperature.

4) Maximum permissible mains short-circuit current

Device type (size 9/10/11):	SK 5xxE…	-902-340-	-113-340-	-133-340-	-163-340-
	Size	**9**	**10**	**10**	**11**
Nominal motor power (4-pole standard motor)	400 V	90.0 kW	110.0 kW	132.0 kW	160.0 kW
	480 V	125 hp	150 hp	180 hp	220 hp
Mains voltage	**400 V**	**3 AC** 380 … 480 V, -20% / +10%, 47 … 63 Hz			
Input current	rms	252 A	308 A	364 A	448 A
	FLA	218 A	252 A	300 A	370 A
Output voltage	**400 V**	3 AC 0 – Mains voltage			
Output current	rms	180 A	220 A	260 A	320 A
	FLA	156 A	180 A	216 A	264 A
Min. braking resistance	Accessories	6 Ω	3.2 Ω	3.0 Ω	2.6 Ω
Pulse frequency	Range	3 … 8 kHz			
	Factory setting	4 kHz			
Ambient temperature[1]	S1	40 °C	40 °C	40 °C	40 °C
	S3 80%, 10 min.	-	-	-	-
	S3 70%, 10 min.	-	-	-	-
Type of ventilation		Fan cooling, temperature-controlled switching thresholds: [2] ON = 56 °C, OFF = 52 °C			
Fan (blower) speed control		Between 52 °C and approx. 70 °C[3]	No speed control! [4]		
		General fuses (AC) (recommended)			
Slow-blowing		315 A	350 A	350 A	400 A

	Class	Isc [5] [A] 10 000		65 000	100 000		**Fuses (AC), UL-approved**			
Fuse	RK5 (480 V)	x					250 A	-	-	-
Fuse	CC, J, R, T, G, L (600 V)				x		250 A	-	-	-
CB	(480 V)	x		x			250 A	-	-	-

1) When using safe functions (STO and SS1), restrictions regarding the permissible temperature range according to BU 0530 must be noted.

2) Short test run after connection of the mains voltage or control voltage

3) In case of frequency inverter overload, the fan speed is increased to 100% – regardless of the actual device temperature.

4) The fans turn on sequentially (interval of approx. 1.8 s)

5) Maximum permissible mains short-circuit current

7.4 General conditions for ColdPlate technology

The standard frequency inverter is supplied with a smooth flat mounting surface instead of a heat sink. This means that the FI must be cooled via the mounting surface, but has a low installation depth.

For all devices there is no fan.

In the selection of a suitable cooling system (e.g. liquid-cooled mounting plate) the thermal resistance R_{th} and the heat to be dissipated from the P_V modulus of the frequency inverter must be taken into account. For example, the supplier of the appropriate control cabinet system can provide details for the correct selection of the mounting plate.

The mounting plate has been correctly selected if its R_{th} value is less than the values stated below.

NOTE:

Before the device is fitted to the mounting plate, any protective film must be removed. A suitable heat-conducting paste must be used.

1~ 115V - devices	Pv module [W]	Max. Rth [K/W]	Cooling area [m²][1)]
SK 5xxE-250-112-O-CP	12.0	2.33	0.12
SK 5xxE-250-112-O-CP	16.5	1.70	0.17
SK 5xxE-550-112-O-CP	23.9	1.17	0.24
SK 5xxE-750-112-O-CP	35.7	0.78	0.36
SK 5xxE-111-112-O-CP	53.5	0.39	0.54

1) Required cooling area, determined under the following general conditions: Control cabinet, height approx. 2 m, ventilation by free convection, mounting plate: Galvanised sheet steel, not painted, thickness approx. 3 mm.

Table 31: Technical data, ColdPlate 115V devices

230V - devices Single phase operation	Pv module [W]	Max. Rth [K/W]	Cooling area [m²][1)]
SK 5xxE-250-323-A-CP	13.6	2.05	0.14
SK 5xxE-370-323-A-CP	18.5	1.52	0.19
SK 5xxE-550-323-A-CP	26.9	1.04	0.27
SK 5xxE-750-323-A-CP	38.8	0.72	0.39
SK 5xxE-111-323-A-CP	59.4	0.35	0.6
SK 5xxE-151-323-A-CP	72.1	0.29	0.73
SK 5xxE-221-323-A-CP [2)]	87.9	0.24	0.88

1) Required cooling area, determined under the following general conditions: Control cabinet, height approx. 2 m, ventilation by free convection, mounting plate: Galvanised sheet steel, not painted, thickness approx. 3 mm.

2) In contrast to the standard device the SK 5xxE-221-323-A-CP is only available in size 3 for S1-operation.

Table 32: Technical data, ColdPlate 230V devices, single phase operation

230V - devices 3 phase operation	Pv module [W]	Max. Rth [K/W]	Cooling area [m²][1)]
SK 5xxE-750-323-A-CP	37.3	0.75	0.38
SK 5xxE-111-323-A-CP	56.7	0.37	0.57
SK 5xxE-151-323-A-CP	67.7	0.31	0.68
SK 5xxE-221-323-A-CP [2)]	94.2	0.22	0.95
SK 5xxE-301-323-A-CP	107.5	0.20	1.08
SK 5xxE-401-323-A-CP	147.7	0.14	1.48

1) Required cooling area, determined under the following general conditions: Control cabinet, height approx. 2 m, ventilation by free convection, mounting plate: Galvanised sheet steel, not painted, thickness approx. 3 mm.

2) In contrast to the standard device the SK 5xxE-221-323-A-CP is only available in size 3 for S1-operation.

Table 33: Technical data, ColdPlate 230V devices, three phase operation

3~ 400V- devices	Pv module [W]	Max. Rth [K/W]	Cooling area [m²][1)]
SK 5xxE-550-340-A-CP	15.7	1.78	0.16
SK 5xxE-750-340-A-CP	22.0	1.27	0.23
SK 5xxE-111-340-A-CP	31.1	0.90	0.32
SK 5xxE-151-340-A-CP	42.1	0.66	0.43
SK 5xxE-221-340-A-CP	62.6	0.45	0.63
SK 5xxE-301-340-A-CP	85.7	0.25	0.86
SK 5xxE-401-340-A-CP	115.3	0.18	1.16
SK 5xxE-551-340-A-CP	147.7	0.15	1.48
SK 5xxE-751-340-A-CP	178.0	0.12	1.78

1) Required cooling area, determined under the following general conditions: Control cabinet, height approx. 2 m, ventilation by free convection, mounting plate: Galvanised sheet steel, not painted, thickness approx. 3 mm.

Table 34: Technical data, ColdPlate 400V devices

The following points must be complied with to ensure the R_{th}:

- The maximum heat sink temperature (T_{kk}) of 70°C and the maximum internal temperature of the control cabinet (T_{amb}) of 40°C must not be exceeded. Suitable cooling must be ensured.
- For installation in a control cabinet, the heat distribution must be taken into account, so that the available cooling area is used to the maximum extent. Through convection, the air on the rear side of the cooling surface heats the upper area more than the area under the source of heat. The device should therefore be mounted in the lower area of the control cabinet to achieve optimum use of the cooling surface.
- The ColdPlate and the mounting plate must lie flat against each other (max.air gap 0.05 mm).
- The contact area of the mounting plate must be at least as large as the area of the ColdPlate
- A suitable heat conducting paste must be applied between the ColdPlate and the mounting plate.
  - The heat conducting paste is not included in the scope of delivery!
  - First remove any protective film.

– All screw connections must be tightened.

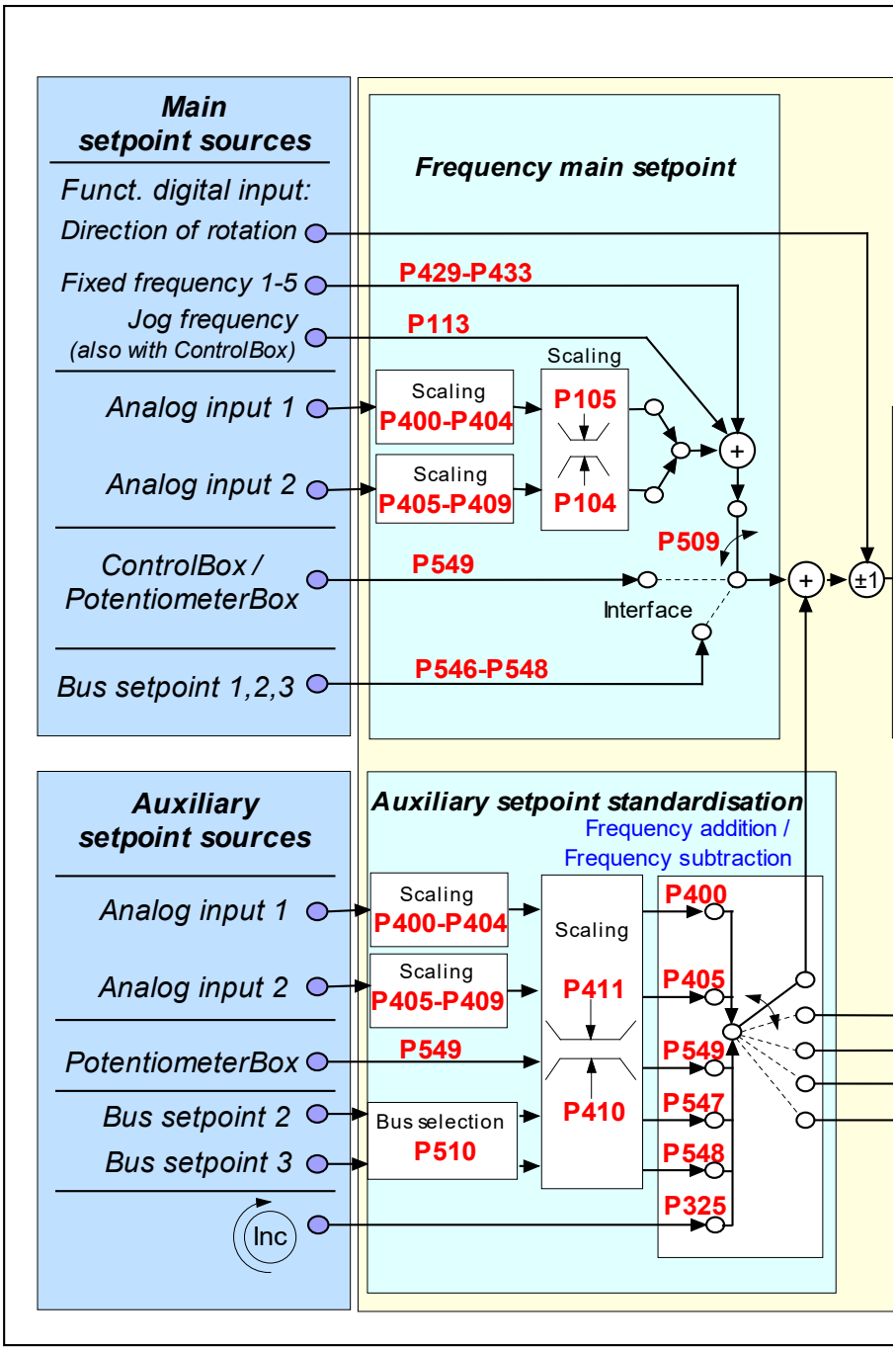
When designing a cooling system the heat to be dissipated by the ColdPlate device, (P_v-module) must be taken into account. For the design of the control cabinet the heat production of the device of approx. 2% of the nominal power must be taken into account.

In case of any further queries, please contact Getriebebau NORD.

8 Additional information

8.1 Setpoint processing

Illustration of setpoint processing for SK 500E…SK 535E devices. This should be used analogously for SK 540E devices.



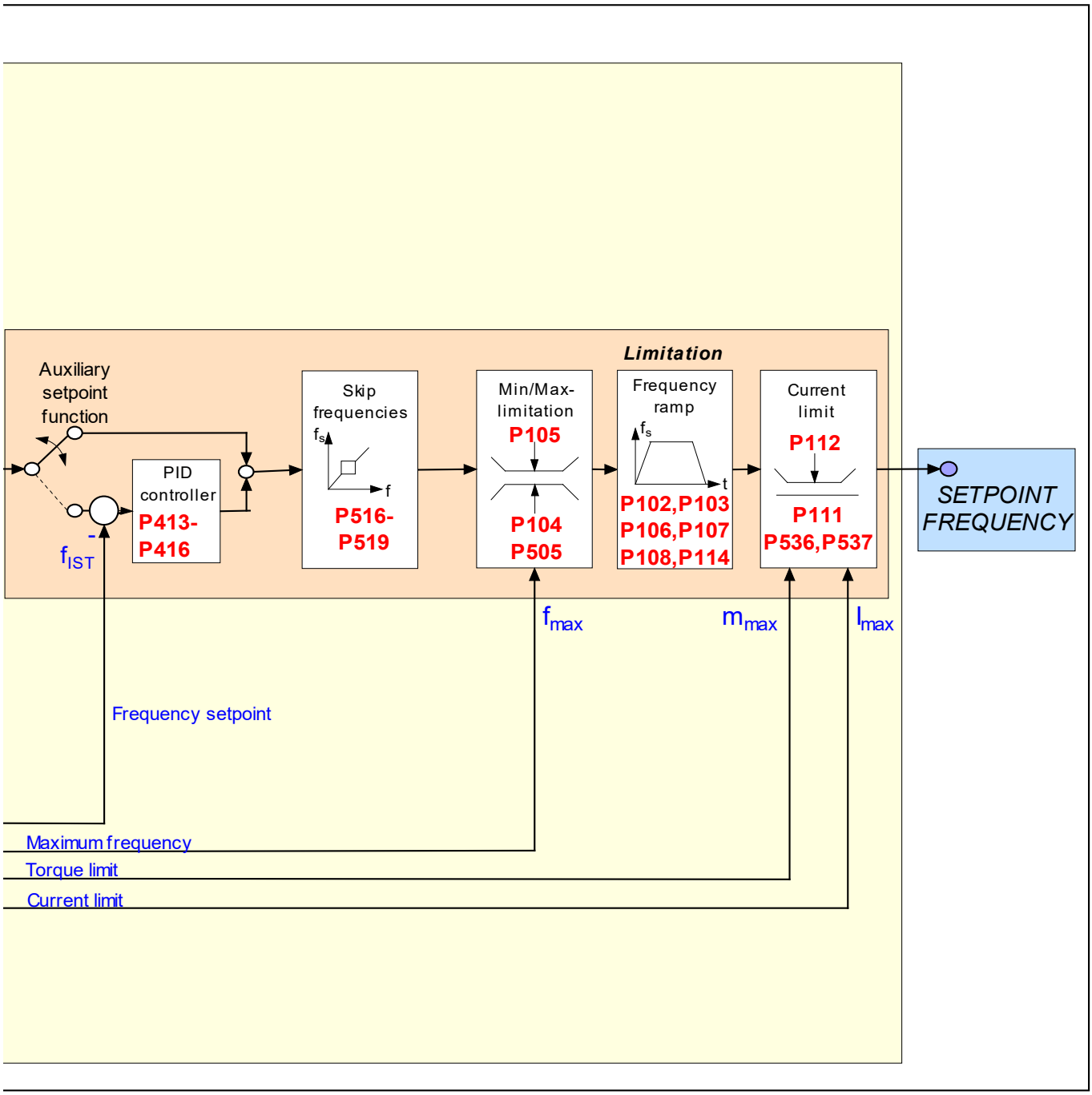
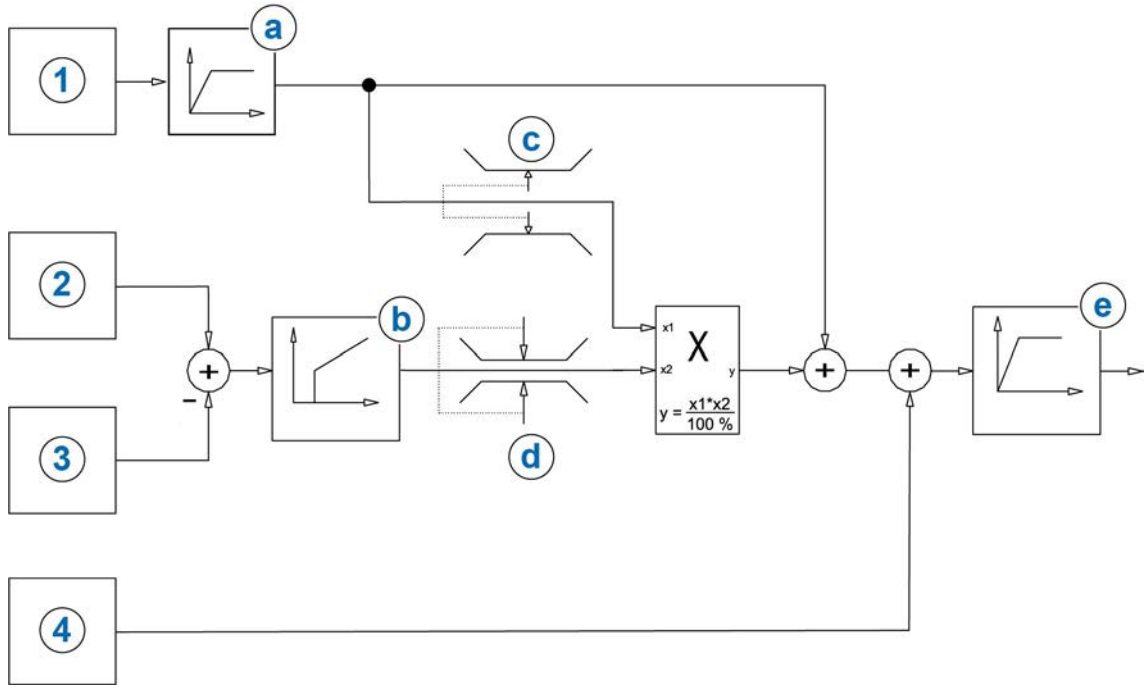


Fig. 13: Setpoint processing

8.2 Process controller

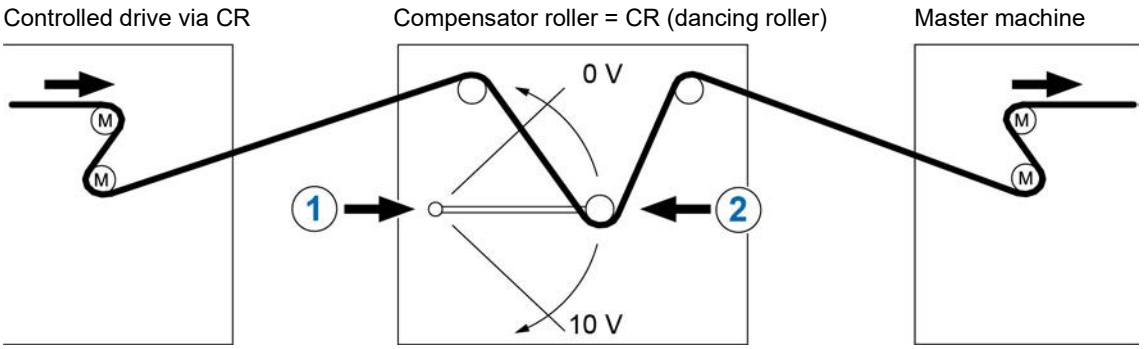
The process controller is a PI controller, with which the controller output can be limited. In addition, the output is scaled to a master setpoint on a percentage basis. This way, you can control a downstream drive with the master setpoint, and readjust with the PI controller.



1	Master setpoint	Analogue input 1 (P400 = {4}) or analogue input 2
2	Nom.val process ctrl	P412 = 0.0–10.0 V
3	Actual value	Analogue input 1 (P400 = {14}) or analogue input 2
4	Add. process control	Analogue input (P400 = {16})
a	Ramptime PID control	P416
b	P factor I factor	P413 P414
c	Min. limitation	P466
d	Max. limitation	P415
e	Acceleration time	P102

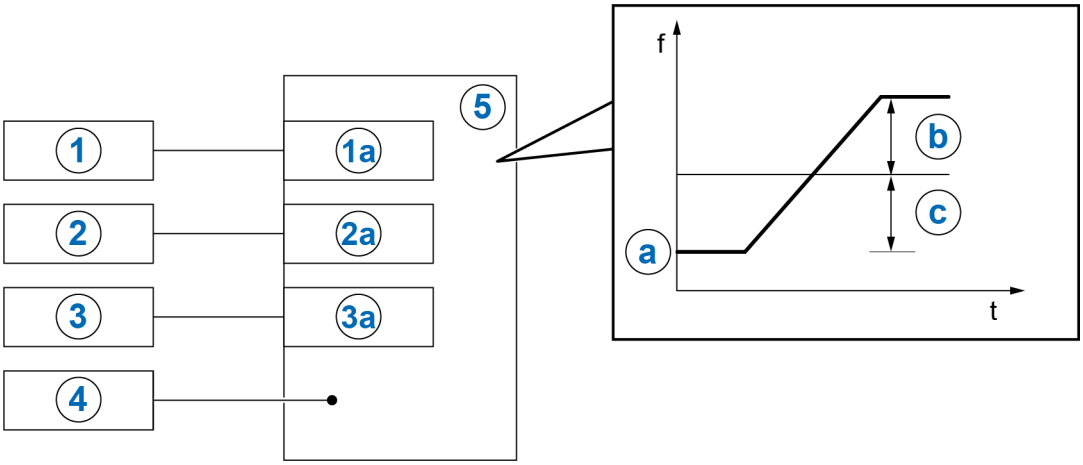
Figure 14: Flow chart: Process controller

8.2.1 Sample application: Process controller



1 Current position of CR via potentiometer 0 … 10 V

2 Centre = 5 V setpoint position



1	Setpoint of master machine	**1 a**	Analog input 1
2	Enable right	**2 a**	Digital input 1
3	Current position of compensator roller	**3 a**	Analog input 2
4	Correction factor Setpoint position of compensator roller via parameter P412	**5**	Frequency inverter
a	Setpoint of master machine		
b	Control limit P415 in % of setpoint		
c	Control limit P415		

Figure 15: Sample application: Dancing roller

8.2.2 Process controller parameter settings

Example: SK 500E, setpoint frequency: 50 Hz, control limits: +/- 25%

P105 (maximum frequency) [Hz]

$$\geq Setpointfrq.\,[\mathrm{Hz}] + \left(\frac{Setpointfrq.\,[Hz] \times P415\,[\%]}{100\%} \right)$$

Example: $\geq 50Hz + \frac{50Hz \times 25\%}{100\%} = \mathbf{62.5Hz}$

P400 (Funct. analog input): **„4“** (frequency addition)

P411 (setpoint frequency) [Hz]: Set frequency with 10 V at analog input 1

Example: **50 Hz**

P412 (Process controller setpoint): CR middle position / Default setting **5V** (adjust if necessary)

P413 (P controller) [%]: Factory setting **10%** (adjust if necessary)

P414 (I-controller) [% / ms]: recommended **100**%/s

P415 (limitation +/-) [%]: Controller limitation (see above)

Note:
In the function process controller, parameter P415 is used as a controller limiter downstream from the PI controller. This parameter therefore has a double function.

Example: **25%** of setpoint

P416 (ramp before controller) [s]: Factory setting **2s** (if necessary, adjust to match controller behaviour)

P420 (Funct. digital input 1): **"1"** Enable right

P405 (Funct. Analoginput 2): **„14“** actual value PID process controller

8.3 Electromagnetic compatibility (EMC)

If the device is installed according to the recommendations in this manual, it meets all EMC directive requirements, as per the EMC product standard EN 61800-3.

8.3.1 General Provisions

As of July 2007, all electrical equipment which has an intrinsic, independent function and which is sold as an individual unit for end users, must comply with Directive 2004/108/EEC (formerly Directive EEC/89/336). There are three different ways for manufacturers to indicate compliance with this directive:

1. *EU Declaration of Conformity*

   This is a declaration from the manufacturer, stating that the requirements in the applicable European standards for the electrical environment of the equipment have been met. Only those standards which are published in the Official Journal of the European Community may be cited in the manufacturer's declaration.

2. *Technical documentation*

   Technical documentation can be produced which describes the EMC characteristics of the device. This documentation must be authorised by one of the "Responsible bodies" named by the responsible European government. This makes it possible to use standards which are still in preparation.

3. *EU Type test certificate*

   This method only applies to radio transmitter equipment.

The devices only have an intrinsic function when they are connected to other equipment (e.g. to a motor). The base units cannot therefore carry the CE mark that would confirm compliance with the EMC directive. Precise details are therefore given below about the EMC behaviour of this product, based on the proviso that it is installed according to the guidelines and instructions described in this documentation.

The manufacturer can certify that his equipment meets the requirements of the EMC directive in the relevant environment with regard to their EMC behaviour in power drives. The relevant limit values correspond to the basic standards EN 61000-6-2 and EN 61000-6-4 for interference immunity and interference emissions.

8.3.2 EMC evaluation

Two standards must be observed when evaluating electromagnetic compatibility.

1. ***EN 55011 (environmental standard)***

   In this standard, the limit values are defined in dependence on the basic environment in which the product is operated. A distinction is made between two environments, where the ***first environment*** describes the non-industrial ***living and business area*** without its own high-voltage or medium-voltage distribution transformers. The ***second environment*** defines ***industrial areas***, which are not connected to the public low-voltage network, but have their own high-voltage or medium-voltage distribution transformers. The limit values are subdivided into ***classes A1, A2 and B***.

2. ***EN 61800-3 (product standard)***

   In this standard, the limit values are defined in dependence on the usage area of the product. The limit values are subdivided into ***categories C1, C2, C3 and C4***, where class C4 basically only applies to drive systems with higher voltage (≥ 1000 V AC) or higher current (≥ 400 A). However, class C4 can also apply to the individual device if it is incorporated in complex systems.

The same limit values apply to both standards. However, the standards differ with regard to an application that is extended in the product standard. The operator decides which of the two standards applies, whereby the environmental standard typically applies in the event of a fault remedy.

The main connection between the two standards is explained as follows:

Category according to EN 61800-3	C1	C2	C3
Limit value class according to EN 55011	B	A1	A2
Operation permissible in First environment (living environment)	X	X [1)]	-
Second environment (industrial environment)	X	X [1)]	X [1)]
Note required in accordance with EN 61800-3	-	[2)]	[3)]
Distribution channel	Generally available	Limited availability	
EMC expertise	No requirements	Installation and commissioning by EMC expert	

1) Device used neither as a plug-in device nor in moving equipment

2) "The drive system can cause high-frequency interference in a living environment that may make interference suppression measures necessary."

3) "The drive system is not intended for use in a public low-voltage network that feeds residential areas."

Table 35: EMC comparison between EN 61800-3 and EN 55011

8.3.3 EMC of device

NOTICE

EMC interference to the environment

This device produces high-frequency interference, which may make additional suppression measures necessary in domestic environments (see chapter 8.3 "Electromagnetic compatibility (EMC)").

- Use of shielded motor cables is essential in order to comply with the specified radio interference suppression level.

The frequency inverter is designed for connection in industrial networks. In principle, it generates **harmonics** that exceed the harmonic limit values of EN IEC 61000-3-2 or EN IEC 61000-3-12. Additional external filtering measures are required to connect the individual frequency inverter to the public low-voltage network in accordance with IEC 61000-3-2 and IEC 61000-3-1.

If one or more frequency inverters are installed in a facility within the scope of IEC 61000-3-2 and IEC 61000-3-12, the requirements of these standards apply to the complete facility and not to the individual frequency inverter. The application of harmonic limit values to every frequency inverter is not recommended from neither a technical nor an economical point of view. Rather, a global approximation should be applied for filtering the entire system, which is based on the addition of all harmonic currents generated in the system. The system operator is responsible for this procedure.

Voltage fluctuations in a supply network essentially depend on the following factors:

- System design
- System impedance
- Load cycles

Therefore, the manufacturer of the machine or the system operator is responsible for evaluating the voltage fluctuations and ensuring compliance with the limit values according to IEC 61000-3-3 or IEC 61000-3-11.

The device is exclusively intended for commercial use. It is therefore not subject to the requirements of the standard EN 61000-3-2 for radiation of harmonics.

The limit value classes are only achieved if

- the wiring is EMC-compliant
- the length of shielded motor cable does not exceed the permissible limits

The motor cable shielding must be connected to both sides (frequency inverter shield bracket and the metal motor terminal box). Depending on the device version (...-A or ...-O) and according to the type and use of line filters or chokes, different permissible motor cable lengths result for compliance with the declared limit value classes.

Information

Shielded motor cable > 30 m

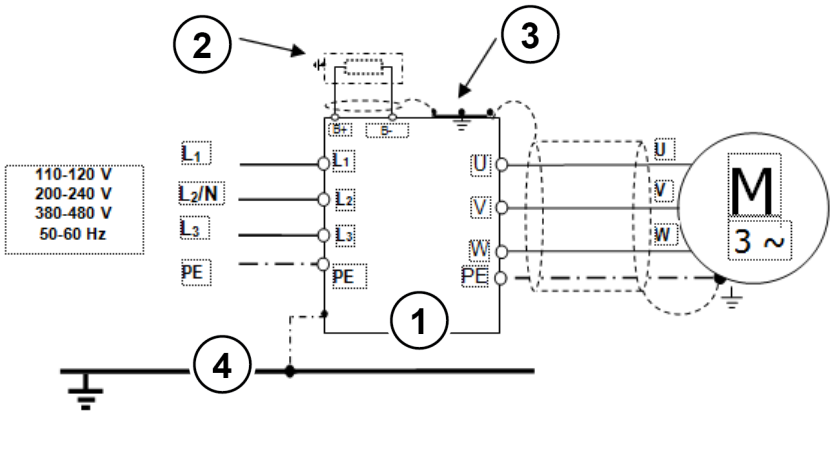
For connection of shielded motor cables with a length > 30 m, the current monitoring may respond, in particular with low-power frequency inverters, so that use of an output choke (SK CO1…) is also necessary.

Device type	Jumper position / DIP: "EMC filter" (chapter 2.9.2)	Conducted emissions 1 150 kHz–30 MHz	
		Class C2	Class C1
SK 5xxE-250-323-A … SK 5xxE-401-323-A	3–2	20 m	5 m
	3–3	5 m	-
SK 5x5E-551-323-A … SK 5x5E-182-323-A	4–2	20 m	-
SK 5xxE-550-340-A … SK 5xxE-751-340-A	3–2	20 m	5 m
	3–3	5 m	-
SK 5xxE-550-340-A … SK 5xxE-751-340-A + suitable SK NHD-… footprint combined filter	3–2	100 m	50 m
SK 5xxE-550-340-O … SK 5xxE-751-340-O + suitable SK NHD-… footprint combined filter	3–2	100 m	25 m
SK 5x5E-112-340-A … SK 5x5E-372-340-A	4–2	20 m	-
SK 5x5E-112-340-A … SK 5x5E-372-340-A + suitable SK LF2-… footprint combined filter	4–2	100 m	50 m
SK 5x5E-112-340-O … SK 5x5E-372-340-O + suitable SK LF2-… footprint combined filter	4–2	100 m	25 m
SK 5x5E-452-340-A … SK 5x5E-163-340-A	DIP: ON	20 m	-

Table 36: EMC, max. shielded motor cable length with regard to compliance with the limit value classes

EMC overview of standards that are used in accordance with EN 61800-3 as checking and measuring procedures:		
Interference emission		
Cable-related emission (interference voltage)	EN 55011	C2
		C1 (size 1-4)
Radiated emission (interference field strength)	EN 55011	C2
		-
Interference immunity EN 61000-6-1, EN 61000-6-2		
ESD, discharge of static electricity	EN 61000-4-2	6 kV (CD), 8 kV (AD)
EMF, high frequency electro-magnetic fields	EN 61000-4-3	10 V/m; 80 – 1000 MHz
Burst on control cables	EN 61000-4-4	1 kV
Burst on mains and motor cables	EN 61000-4-4	2 kV
Surge (phase-phase / phase-ground)	EN 61000-4-5	1 kV / 2 kV
Cable-led interference due to high frequency fields	EN 61000-4-6	10 V, 0.15 – 80 MHz
Voltage fluctuations and drops	EN 61000-2-1	+10 %, -15 %; 90 %
Voltage asymmetries and frequency changes	EN 61000-2-4	3 %; 2 %

Table 37: Overview according to product standard EN 61800-3



1	FI
2	Brake resistance (option)
3	shield angle
4	Functional earthing
PE	Protective earth

Figure 16: Wiring recommendation

8.3.4 Declarations of Conformity

GETRIEBEBAU NORD

Member of the NORD DRIVESYSTEMS Group

Getriebebau NORD GmbH & Co. KG

Getriebebau-Nord-Str. 1 . 22941 Bargteheide, Germany . Fon +49(0)4532 289 - 0 . Fax +49(0)4532 289 - 2253 . info@nord.com

C310600_1021

EU Declaration of Conformity

In the meaning of the EU directives 2014/35/EU Annex IV, 2014/30/EU Annex II, 2009/125/EG Annex IV and 2011/65/EU Annex VI

Page 1 of 1

Getriebebau NORD GmbH & Co. KG as manufacturer in sole responsibility hereby declares, that the variable speed drives of the product series NORDAC PRO

- **SK 500E-xxx-123-B-.. , SK 500E-xxx-323-.-.. , SK 500E-xxx-340-.-.. , SK 500E-xxx-350-.-..**
  (xxx= 250, 370, 550, 750, 111, 151, 221, 301, 401, 551, 751, 112, 152, 182, 222, 302, 372, 452, 552, 752, 902, 113, 133, 163, 203)
  also in these functional variants:
  SK 501E-..., SK 505E-..., SK 510E-..., SK 511E-..., SK 515E-..., SK 520E-..., SK 525E-..., SK 530E-..., SK 531E-..., SK 535E-..., SK 540E-..., SK 545E-...
  and the further options/accessories:
  SK TU3-... , SK PAR-3. , SK CSX-3. , SK SSX-3A, SK POT1-. , SK EBIOE-2, SK EBGR-1, SK TIE5-BT-STICK, SK-EMC 2-. , SK DRK1-1, SK TH1-. , SK CI1-.... , SK CO1-... , SK CIF-... , SK NHD-... , SK LF2-... , HLD 110-500/.. , SK DCL-950/... , SK BR.-...

comply with the following regulations:

Low Voltage Directive	**2014/35/EU**	OJ. L 96 of 29.3.2014, p. 357–374
EMC Directive	**2014/30/EU**	OJ. L 96 of 29.3.2014, p. 79–106
Ecodesign Directive	**2009/125/EG**	OJ. L 285 of 31.10.2009, p. 10–35
Regulation (EU) Ecodesign	**2019/1781**	OJ. L 272 of 25.10.2019, p. 74–94
RoHS Directive	**2011/65/EU**	OJ. L 174 of 1.7.2011, p. 88–11
Delegated Directive (EU)	**2015/863**	OJ. L 137 of 4.6.2015, p. 10–12

Applied standards:

EN 61800-5-1:2007+A1:2017	EN 61800-3:2018	EN 61800-9-1:2017
EN 60529:1991+A1:2000+A2:2013+AC:2016	EN 63000:2018	EN 61800-9-2:2017

It is necessary to notice the data in the operating manual to meet the regulations of the EMC-Directive. Specially take care about correct EMC installation and cabling, differences in the field of applications and if necessary original accessories.

First marking was carried out in 2005.

Bargteheide, 12.03.2021

U. Küchenmeister
Managing Director

pp F. Wiedemann
Head of Inverter Division

NORD GEAR LIMITED

Member of the NORD DRIVESYSTEMS GROUP

NORD Gear Limited
11 Barton Lane, Abingdon, Oxfordshire, United Kingdom OX14 3NB | Tel. No.: +44 1235 534404 | Email: GB-Sales@nord.com

DoC number C350600_0821_EN_UKCA

Declaration of Conformity

NORD Gear Limited hereby declares under sole responsibility that the product series as originally delivered:

SK 500E-xxx-123-B-.., SK 500E-xxx-323-.-.., SK 500E-xxx-340-.-.., SK 500E-xxx-350-.-..
(xxx = 250, 370, 550, 750, 111, 151, 221, 301, 401, 551, 751, 112, 152, 182, 222, 302, 372, 452, 552, 752, 902, 113, 133, 163, 203)
also in these functional variants:
SK 501E-..., SK 505E-..., SK 510E-..., SK 511E-..., SK 515E-..., SK 520E-..., SK 525E-...,
SK 530E-..., SK 531E-..., SK 535E-..., SK 540E-..., SK 545E-...

and the further options/accessories:
SK TU3-..., SK PAR-3., SK CSX-3., SK SSX-3A, SK POT1-., SK EBIOE-2, SK EBGR-1,
SK TIE5-BT-STICK, SK-EMC 2-., SK DRK1-1, SK TH1-., SK CI1-... SK CO1-..., SK CIF-...,
SK NHD-..., SK LF2-..., HLD 110-500/.., SK DCL-950/..., SK BR.-...

complies with the following statutory requirements and carries the UKCA marking accordingly:	and conforms with the following designated standards:
Electrical Equipment (Safety) Regulations S.I. 2016/1101 (as amended)	EN 61800-5-1:2007+A1:2017 EN 61800-9-1:2017 EN 61800-9-2:2017 EN 60529:1991+A1:2000+A2:2013+AC:2016
Electromagnetic Compatibility Regulations S.I. 2016/1091 (as amended)	EN 61800-3:2004+A1:2012+AC:2014
Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations S.I. 2012/3032 (as amended)	BS EN IEC 63000:2018

According to the EMC directive, the listed devices are not independently operable products, they are intended for installation in machines. Compliance to the directive requires the correct installation of the product, it is necessary to take notice of the data and safety instructions in the installation and operating manual. Specifically take care regarding the correct EMC installation and cabling requirements.

Abingdon, 07.04.2021

Andrew Stephenson
Managing Director

8.4 Reduced output power

The frequency inverters are designed for special overload situations. For example, 1.5x overcurrent can be used for 60 s. For approx. 3.5 s, 2x overcurrent is possible. A reduction of the overload capacity or its duration must be considered for the following circumstances:

- Output frequencies < 4.5 Hz and DC voltage (stationary pointer)
- Pulse frequencies greater than the nominal pulse frequency (P504)
- Increased mains voltages > 400 V
- Increased heat sink temperature

The following characteristic curves can be used to obtain the corresponding current/power limit.

8.4.1 Increased heat dissipation due to pulse frequency

This illustration shows how the output current must be reduced, depending on the pulse frequency for 230V and 400V devices, in order to avoid excessive heat dissipation in the frequency inverter.

For 400V devices, the reduction begins at a pulse frequency above 6kHz (≥ size 8: above 4kHz). For 230V devices, the reduction begins at a pulse frequency above 8kHz.

The diagram shows the possible current load capacity for continuous operation.

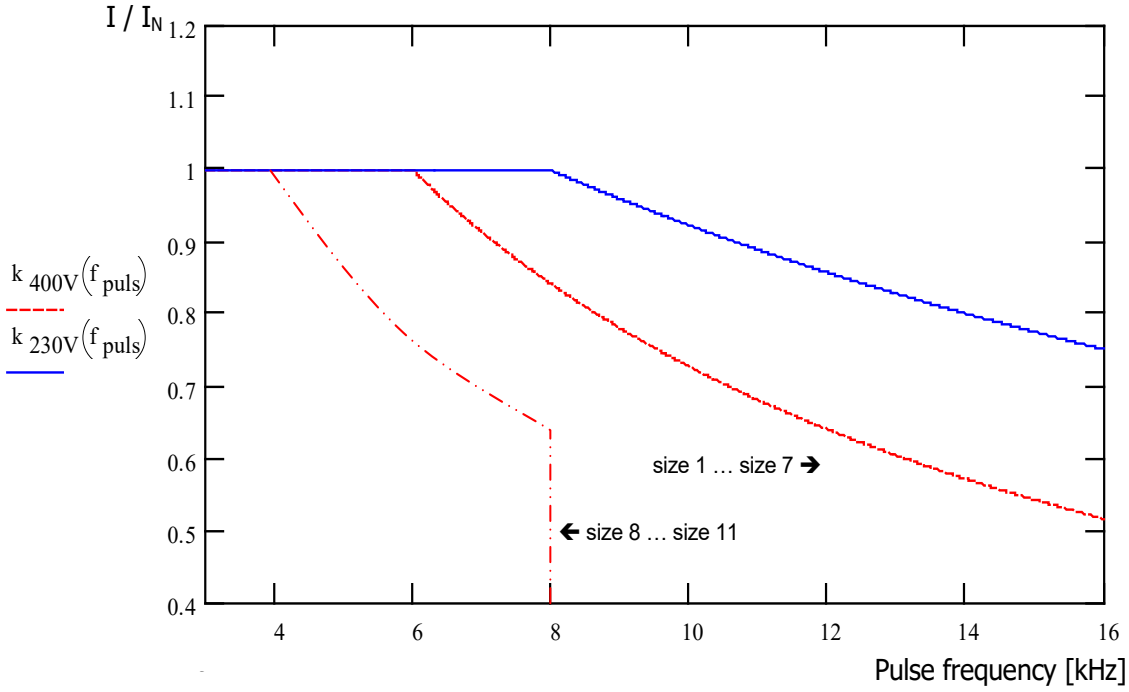


Figure 17: Heat losses due to pulse frequency

8.4.2 Reduced overcurrent due to time

The possible overload capacity changes depending on the duration of an overload. Several values are cited in this table. If one of these limiting values is reached, the frequency inverter must have sufficient time (with low utilisation or without load) in order to regenerate itself.

If operated repeatedly in the overload region at short intervals, the limiting values stated in the tables are reduced.

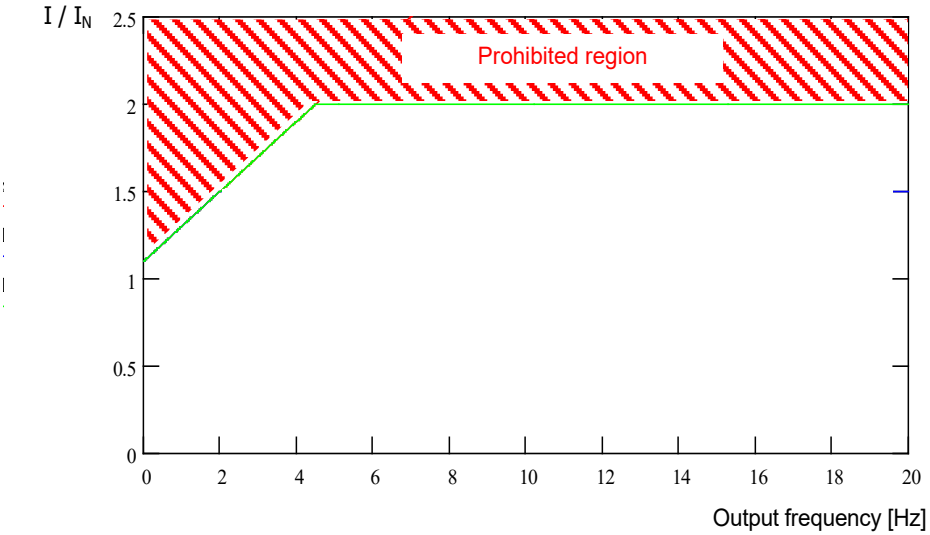
230V devices: Reduced overload capacity (approx.) due to pulse frequency (P504) and time						
Pulse frequency [kHz]	Time [s]					
	> 600	60	30	20	10	3.5
3...8	110%	150%	170%	180%	180%	200%
10	103%	140%	155%	165%	165%	180%
12	96%	130%	145%	155%	155%	160%
14	90%	120%	135%	145%	145%	150%
16	82%	110%	125%	135%	135%	140%

400V devices: Reduced overload capacity (approx.) due to pulse frequency (P504) and time						
Pulse frequency [kHz]	Time [s]					
	> 600	60	30	20	10	3.5
3...6	110%	150%	170%	180%	180%	200%
8	100%	135%	150%	160%	160%	165%
10	90%	120%	135%	145%	145%	150%
12	78%	105%	120%	125%	125%	130%
14	67%	92%	104%	110%	110%	115%
16	57%	77%	87%	92%	92%	100%

Table 38: Overcurrent relative to time

8.4.3 Reduced overcurrent due to output frequency

To protect the power unit at low output frequencies (<4.5 Hz) a monitoring system is provided, with which the temperature of the IGBTs (*insulated-gate bipolar transistor*) due to high current is determined. In order to prevent current being taken off above the limit shown in the diagram, a pulse switch-off (P537) with a variable limit is introduced. At a standstill, with 6 kHz pulse frequency, current above 1.1x the nominal current cannot be taken off.



The upper limiting values for the various pulse frequencies can be obtained from the following tables. In all cases, the value (10 … 201) which can be set in parameter P537, is limited to the value stated in the tables according to the pulse frequency. Values below the limit can be set as required.

230 V devices: Reduced overload capacity (approx.) due to pulse frequency (P504) and output frequency							
Pulse frequency [kHz]	Output frequency [Hz]						
	4.5	3.0	2.0	1.5	1.0	0.5	0
3 ... 8	200 %	170 %	150 %	140 %	130 %	120 %	110 %
10	180 %	153 %	135 %	126 %	117 %	108 %	100 %
12	160 %	136 %	120 %	112 %	104 %	96 %	95 %
14	150 %	127 %	112 %	105 %	97 %	90 %	90 %
16	140 %	119 %	105 %	98 %	91 %	84 %	85 %

400V devices: Reduced overload capacity (approx.) due to pulse frequency (P504) and output frequency							
Pulse frequency [kHz]	Output frequency [Hz]						
	4.5	3.0	2.0	1.5	1.0	0.5	0
3 ... 6	200 %	170 %	150 %	140 %	130 %	120 %	110 %
8	165 %	140 %	123 %	115 %	107 %	99 %	90 %
10	150 %	127 %	112 %	105 %	97 %	90 %	82 %
12	130 %	110 %	97 %	91 %	84 %	78 %	71 %
14	115 %	97 %	86 %	80 %	74 %	69 %	63 %
16	100 %	85 %	75 %	70 %	65 %	60 %	55 %

Table 39: Overcurrent relative to pulse and output frequency

8.4.4 Reduced output current due to low voltage

The frequency inverters are thermally designed with regard to the rated output currents. For lower low voltages larger currents cannot be used in order to keep the output power constant. For mains voltages above 400 V the permissible output current is reduced inversely proportional to the mains voltage in order to compensate for switching losses.

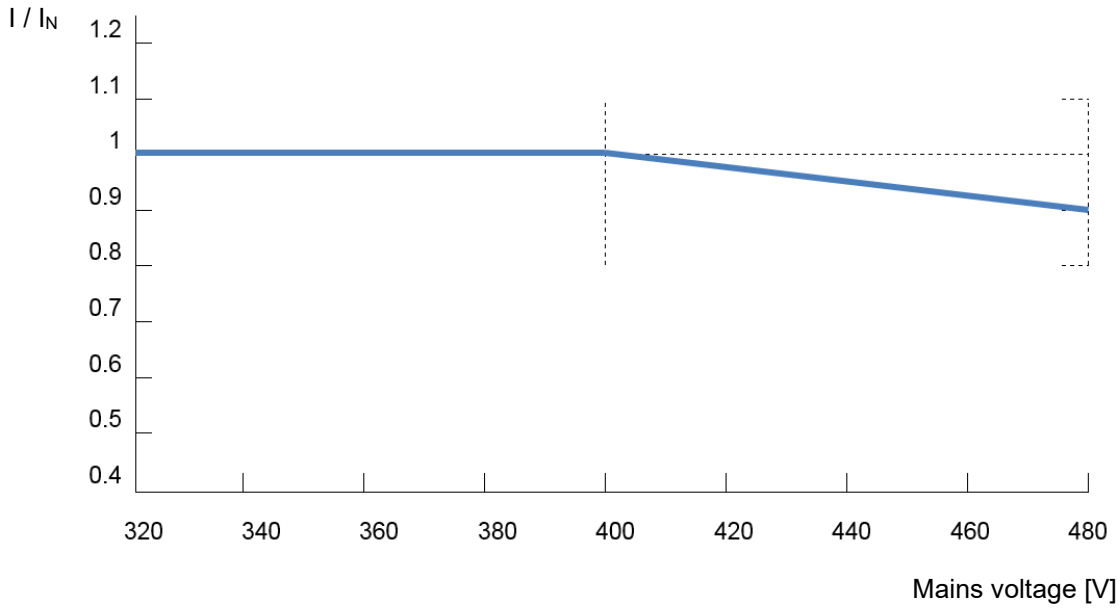


Figure 18: Reduced output current due to low voltage

8.4.5 Reduced output current due to the heat sink temperature

The temperature of the heat sink in included in the calculation of the reduction of output current, so that at low heat sink temperatures, a higher load capacity can be permitted, especially for higher pulse frequencies. At high heat sink temperatures, the reduction is increased correspondingly. The ambient temperature and the ventilation conditions for the device can therefore be optimally exploited.

8.5 Operation on the RCD

When the mains filter is activated (standard configuration), the device is suitable for operation on a RCD (30 mA).

Only all-current sensitive RCDs (type B or B+) must be used.

Please also note the information on the leakage currents in the technical data (see chapter 7.1 "General frequency inverter data")and Chapter 2.9.2 "Adaptation to IT networks".

(🕮 See also document TI 800_000000003)

8.6 Energy efficiency optimisation when operating ASMs

⚠ WARNING

Unexpected movement due to overload

In case of overload of the drive there is a risk that the motor will "break down" (sudden loss of torque). An overload may be caused e.g. by inadequate dimensioning of the drive unit or by the occurrence of sudden peak loads. Sudden peak loads may be of a mechanical origin (e.g. blockage) or may be caused by extremely steep acceleration ramps (P102, P103, P426).

Depending on the type of application, "breakdown" of the motor may cause unexpected movement (e.g. dropping of loads by lifting equipment).

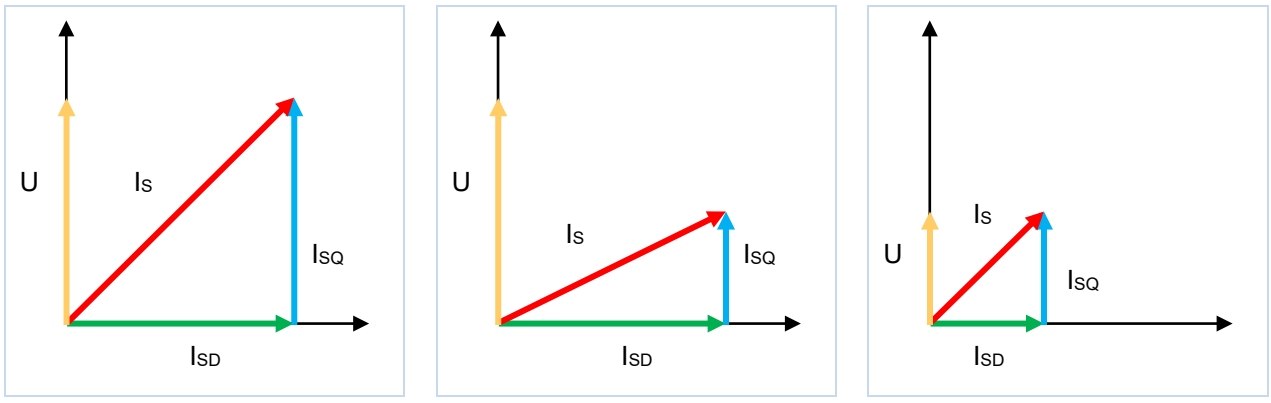
To prevent any risk, the following must be observed:

- For lifting equipment applications or applications with frequent large load changes, parameter P219 must remain in the factory setting (100 %).
- Do not inadequately dimension the drive unit, provide adequate overload reserves.
- If necessary, provide fall protection (e.g. for lifting equipment) or equivalent protective measures.

NORD frequency inverters have a low power consumption and are therefore highly efficient. In addition, with the aid of "Automatic flux optimisation" (Parameter (P219)) the inverter provides a possibility for increasing the overall efficiency of the drive in certain applications (in particular applications with partial load).

According to the torque required, the magnetisation current through the frequency inverter or the motor torque is reduced to the level which is required for the momentary drive power. The resulting considerable reduction in power consumption, as well as the optimisation of the cos φ factor of the motor rating in the partial load range contributes to creating optimum conditions both with regard to energy consumption and mains characteristics.

A parameterisation which is different from the factory setting (Factory setting = 100%) is only permissible for applications which do not require rapid torque changes. (For details, see Parameter (P219))



I_S = Motor current vector (line current)
I_{SD} = Magnetisation current vector (magnetisation current)
I_{SQ} = Load current vector (load current)

Figure 19: Energy efficiency due to automatic flux optimisation

8.7 Motor data – characteristic curves (Asynchronous motors)

The possible characteristic curves with which the motors can be operated are explained in the following. For operation with the 50 Hz or 87 Hz characteristic curve, the name plate data of the motor is relevant (🕮 Section 4.1 "Factory settings"). For operation with a 100 Hz characteristic curve, the use of specially calculated motor data is required (🕮 Section 8.7.3 "100 Hz characteristic curve (only 400 V devices)").

8.7.1 50 Hz characteristic curve

(→ Adjustment range 1:10)

For 50 Hz operation, the used motor can be operated up to its rating point at 50 Hz with nominal torque. Operation above 50 Hz is possible, but causes the torque output to reduce in a non-linear manner (see diagram). Above the rating point, the motor enters its field weakening range, as the voltage cannot be increased above the value of the mains voltage if the frequency is increased above 50 Hz.

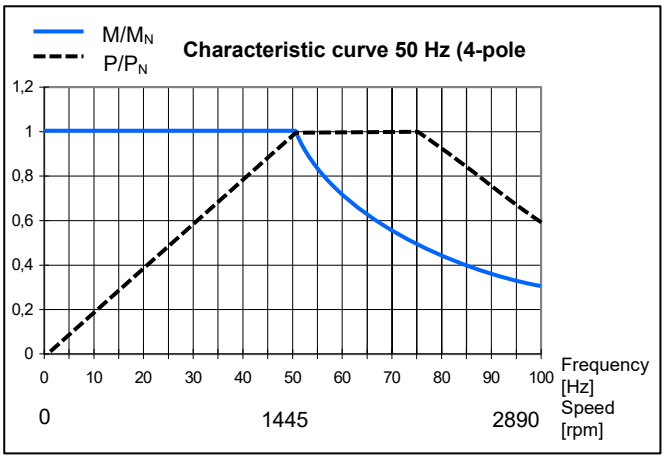


Figure 20: Characteristic curve 50 Hz

Information

Compare motor data with specifications on the name plate.

To be able to optimally adjust the frequency inverter to the motor used, the motor parameters must match with those of the motor.

- Select the motor used in the motor list in parameter **P200**. The motor list indicates the motor data of various NORD motors.
- When using motors of other energy efficiency classes than listed in **P200**, but in particular for use of third-party motors, compare the motor data in parameters **P201** … **P209** with the specifications on the name plate and correct them if necessary.
- Finally, you must calibrate the stator resistance, see **P220**, or enter it manually in **P208**.

115 V / 230 V – frequency inverter

For 115 V devices, the input voltage is doubled in the device so that the required maximum output voltage of 230 V is achieved for the device.

The following data refers to a 230 V/400 V winding of the motor. It applies to IE1 and IE2 motors. Please note that these specifications may vary slightly, as the motors are subject to certain manufacturing tolerances. It is recommended to have the resistance of the connected motor calibrated by the frequency inverter (**P208 / P220**).

Motor (IE1) SK …	**Frequency inverter SK 5xxE-…**	**M_N 1) [Nm]**	**Motor data for parameterisation**							
			F_N [Hz]	n_N [min-1]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
71S/4	250-x23-	1,73	50	1365	1,3	230	0,25	0,79	Δ	39,9
71L/4	370-x23-	2,56	50	1380	1,89	230	0,37	0,71	Δ	22,85
80S/4	550-x23-	3,82	50	1385	2,62	230	0,55	0,75	Δ	15,79
80L/4	750-x23-	5,21	50	1395	3,52	230	0,75	0,75	Δ	10,49
90S/4	111-x23-	7,53	50	1410	4,78	230	1,1	0,76	Δ	6,41
90L/4	151-323-	10,3	50	1390	6,11	230	1,5	0,78	Δ	3,99
100L/4	221-323-	14,6	50	1415	8,65	230	2,2	0,78	Δ	2,78
100LA/4	301-323-	20,2	50	1415	11,76	230	3,0	0,78	Δ	1,71
112M/4	401-323-	26,4	50	1430	14,2	230	4,0	0,83	Δ	1,11
132S/4	551-323-	36,5	50	1450	20,0	230	5,5	0,8	Δ	0,72
132M/4	751-323-	49,6	50	1450	26,8	230	7,5	0,79	Δ	0,46
132MA/4	112-323-	60,6	50	1455	32,6	230	9,2	0,829	Δ	0,39

1) At the rating point

Motor (IE2) SK …	**Frequency inverter SK 5xxE-…**	**M_N 1) [Nm]**	**Motor data for parameterisation**							
			F_N [Hz]	n_N [rpm]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
80SH/4	550-x23-	3,73	50	1415	2,39	230	0,55	0,7	Δ	9,34
80LH/4	750-x23-	5,06	50	1410	3,12	230	0,75	0,75	Δ	6,30
90SH/4	111-x23-	7,32	50	1430	4,26	230	1,1	0,8	Δ	4,96
90LH/4	151-323-	10,1	50	1420	5,85	230	1,5	0,79	Δ	3,27
100LH/4	221-323-	14,5	50	1445	8,25	230	2,2	0,79	Δ	1,73
100AH/4	301-323-	20,3	50	1420	11,1	230	3,0	0,77	Δ	1,48
112MH/4	401-323-	26,6	50	1440	14,1	230	4,0	0,83	Δ	1,00
132SH/4	551-323-	36,6	50	1455	18,8	230	5,5	0,83	Δ	0,60
132MH/4	751-323-	49,1	50	1455	26,2	230	7,5	0,8	Δ	0,42
160MH/4	112-323-	71,7	50	1465	35,5	230	11,0	0,85	Δ	0,26

1) At the rating point

400 V frequency inverter

The following data refer to a power of 2.2 kW on a 230/400 V winding of the motor.

It applies to IE1 and IE2 motors. Please note that these specifications may vary slightly, as the motors are subject to certain manufacturing tolerances. It is recommended to have the resistance of the connected motor calibrated by the frequency inverter (**P208 / P220**).

Motor (IE1) SK …	**Frequency inverter SK 5xxE-…**	**M_N [1] [Nm]**	**Motor data for parameterisation**							
			F_N [Hz]	n_N [min-1]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
80S/4	550-340-	3,82	50	1385	1,51	400	0,55	0,75	Y	15,79
80L/4	750-340-	5,21	50	1395	2,03	400	0,75	0,75	Y	10,49
90S/4	111-340-	7,53	50	1410	2,76	400	1,1	0,76	Y	6,41
90L/4	151-340-	10,3	50	1390	3,53	400	1,5	0,78	Y	3,99
100L/4	221-340-	14,6	50	1415	5,0	400	2,2	0,78	Y	2,78
100LA/4	301-340-	20,2	50	1415	6,8	400	3,0	0,78	Δ	5,12
112M/4	401-340-	26,4	50	1430	8,24	400	4,0	0,83	Δ	3,47
132S/4	551-340-	36,5	50	1450	11,6	400	5,5	0,8	Δ	2,14
132M/4	751-340-	49,6	50	1450	15,5	400	7,5	0,79	Δ	1,42
160M/4	112-340-	72,2	50	1455	20,9	400	11,0	0,85	Δ	1,08
160L/4	152-340-	98,1	50	1460	28,2	400	15,0	0,85	Δ	0,66
180MX/4	182-340-	122	50	1460	35,4	400	18,5	0,83	Δ	0,46
180LX/4	222-340-	145	50	1460	42,6	400	22,0	0,82	Δ	0,35

1) At the rating point

Motor (IE2) SK …	**Frequency inverter SK 5xxE-…**	**M_N [1] [Nm]**	**Motor data for parameterisation**							
			F_N [Hz]	n_N [rpm]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
80SH/4	550-340-	3,82	50	1415	1,38	400	0,55	0,7	Y	9,34
80LH/4	750-340-	5,21	50	1410	1,8	400	0,75	0,75	Y	6,30
90SH/4	111-340-	7,53	50	1430	2,46	400	1,1	0,8	Y	4,96
90LH/4	151-340-	10,3	50	1420	3,38	400	1,5	0,79	Y	3,27
100LH/4	221-340-	14,6	50	1445	4,76	400	2,2	0,79	Y	1,73
100AH/4	301-340-	20,2	50	1420	6,4	400	3,0	0,77	Δ	4,39
112MH/4	401-340-	26,4	50	1440	8,12	400	4,0	0,83	Δ	2,96
132SH/4	551-340-	36,5	50	1455	10,82	400	5,5	0,83	Δ	1,84
132MH/4	751-340-	49,6	50	1455	15,08	400	7,5	0,8	Δ	1,29
160MH/4	112-340-	72,2	50	1465	20,5	400	11,0	0,85	Δ	0,78
160LH/4	152-340-	98,1	50	1465	27,5	400	15,0	0,87	Δ	0,53
180MH/4	182-340-	122	50	1475	34,9	400	18,5	0,84	Δ	0,36
180LH/4	222-340-	145	50	1475	40,8	400	22,0	0,86	Δ	0,31

1) At the rating point

8.7.2 87 Hz characteristic curve (only 400V devices)

(→ Variation 01:17)

The 87 Hz - characteristic represents an extension of the speed adjustment range with a constant motor nominal torque. The following points must be met for realisation:

- Motor delta connection with a motor winding for 230/400 V
- Frequency inverter with an operating voltage 3~400 V
- Output current of frequency inverter must be greater than the delta current of the motor used (ref. value → frequency inverter power ≥ √3 motor power)

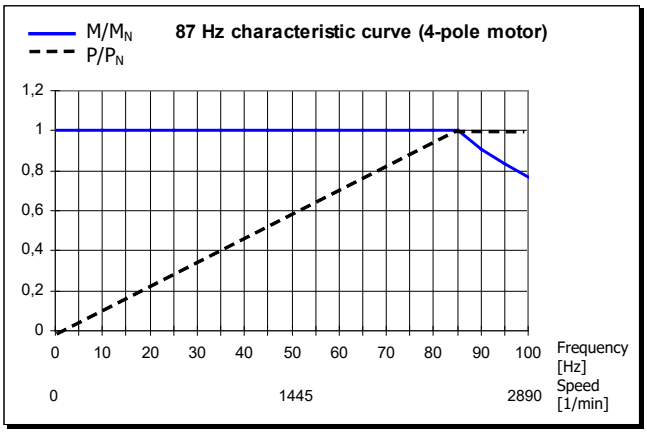


Figure 21: 87 Hz characteristic curve

In this configuration, the motor used has a rated operating point at 230 V/50 Hz and an extended operating point at 400 V/ 87 Hz. This increases the power of the drive by a factor of √3 The nominal torque of the motor remains constant up to a frequency of 87 Hz. Operation of a 230 V winding with 400 V is totally uncritical as the insulation is designed for test voltages of > 1000 V.

Information

The following motor data applies to standard motors with a 230 V/400 V winding.

Motor (IE1) SK …	Frequency inverter SK 5xxE-…	M_N 1) [Nm]	Motor data for parameterisation							
			F_N [Hz]	n_N [min-1]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
71S/4	550-340-	1,73	50	1365	1,3	230	0,25	0,79	Δ	39,9
71L/4	750-340-	2,56	50	1380	1,89	230	0,37	0,71	Δ	22,85
80S/4	111-340-	3,82	50	1385	2,62	230	0,55	0,75	Δ	15,79
80L/4	151-340-	5,21	50	1395	3,52	230	0,75	0,75	Δ	10,49
90S/4	221-340-	7,53	50	1410	4,78	230	1,1	0,76	Δ	6,41
90L/4	301-340-	10,3	50	1390	6,11	230	1,5	0,78	Δ	3,99
100L/4	401-340-	14,6	50	1415	8,65	230	2,2	0,78	Δ	2,78
100LA/4	551-340-	20,2	50	1415	11,76	230	3,0	0,78	Δ	1,71
112M/4	751-340-	26,4	50	1430	14,2	230	4,0	0,83	Δ	1,11
132S/4	112-340-	36,5	50	1450	20,0	230	5,5	0,8	Δ	0,72
132M/4	152-340-	49,6	50	1450	26,8	230	7,5	0,79	Δ	0,46
132MA/4	182-340-	60,6	50	1455	32,6	230	9,2	0,829	Δ	0,39
160MA/4	222-340-	72,2	50	1455	37	230	11	0,85	Δ	0,36

1) At the rating point

Motor (IE2) SK …	Frequency inverter SK 5xxE-…	M_N [1] [Nm]	Motor data for parameterisation							
			F_N [Hz]	n_N [rpm]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
80SH/4	111-340-	3,73	50	1415	2,39	230	0,55	0,7	Δ	9,34
80LH/4	151-340-	5,06	50	1410	3,12	230	0,75	0,75	Δ	6,30
90SH/4	221-340-	7,32	50	1430	4,26	230	1,1	0,8	Δ	4,96
90LH/4	301-340-	10,1	50	1420	5,85	230	1,5	0,79	Δ	3,27
100LH/4	401-340-	14,5	50	1445	8,25	230	2,2	0,79	Δ	1,73
100AH/4	551-340-	20,3	50	1420	11,1	230	3,0	0,77	Δ	1,48
112MH/4	751-340-	26,6	50	1440	14,1	230	4,0	0,83	Δ	1,00
132SH/4	112-340-	36,6	50	1455	18,8	230	5,5	0,83	Δ	0,60
132MH/4	152-340-	49,1	50	1455	26,2	230	7,5	0,8	Δ	0,42
160MH/4	182-340-	71,7	50	1465	35,5	230	11,0	0,85	Δ	0,26
160LH/4	222-340-	97,8	50	1465	46,0	230	15,0	0,87	Δ	0,17

1) At the rating point

Motor (IE3) SK …	Frequency inverter SK 5xxE-…	M_N [1] [Nm]	Motor data for parameterisation							
			F_N [Hz]	n_N [min-1]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
63 SP/4	550-340-	0,84	50	1370	0,68	230	0,12	0,66	Δ	66,7
63 LP/4	550-340-	1,24	50	1385	1,02	230	0,18	0,62	Δ	39,7
71 SP/4	550-340-	1,69	50	1415	1,21	230	0,25	0,71	Δ	24,0
71 LP/4	750-340-	2,51	50	1405	1,58	230	0,37	0,76	Δ	17,7
80 SP/4	111-340-	3,70	50	1420	2,23	230	0,55	0,75	Δ	10,4
80 LP/4	151-340-	5,06	50	1415	3,10	230	0,75	0,72	Δ	6,50
90 SP/4	221-340-	7,35	50	1430	4,12	230	1,1	0,78	Δ	4,16
90 LP/4	301-340-	10,1	50	1415	5,59	230	1,5	0,79	Δ	3,15
100 LP/4 [2]	401-340-	14,4	50	1460	8,13	230	2,2	0,76	Δ	1,77
100 AP/4 [2]	551-340-	19,8	50	1450	10,9	230	3,0	0,8	Δ	1,29
112 MP/4	751-340-	26,5	50	1440	13,6	230	4,0	0,83	Δ	0,91
132 SP/4	112-340-	35,8	50	1465	18,9	230	5,5	0,8	Δ	0,503
132 MP/4	152-340-	49,0	50	1460	27,3	230	7,5	0,77	Δ	0,381
160 SP/4	182-340-	59,8	50	1470	29,0	230	9,2	0,88	Δ	0,295
160 MP/4	182-340-	71,7	50	1465	35,5	230	11,0	0,85	Δ	0,262
160 LP/4		97,8	50	1465	48,3	230	15,0	0,85	Δ	0,169
180 MP/4	302-340-	119	50	1480	58,9	230	18,5	0,84	Δ	0,101
180 LP/4	372-340-	142	50	1475	68,1	230	22,0	0,87	Δ	0,098

1) At the rating point

2) APAB series

8.7.3 100 Hz characteristic curve (only 400 V devices)

(→ adjustment range 1:20)

An operating point 100 Hz / 400 V can be selected for a large speed adjustment range up to a ratio of 1:20. This requires special motor data (see below) that deviates from the usual 50 Hz data. It must be noted that a constant torque is generated over the entire adjustment range, but that it is less than the nominal torque at 50 Hz operation.

The advantage, in addition to the large speed adjustment range, is the better temperature behaviour of the motor. An external fan is not necessarily required in low output speed ranges.

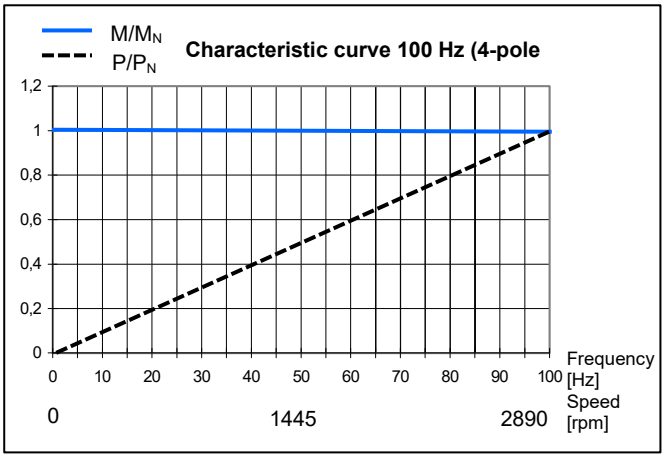


Figure 22: Characteristic curve 100 Hz

Information

The following motor data applies to standard motors with a 230 / 400 V winding. Please note that these specifications may vary slightly, as the motors are subject to certain manufacturing tolerances. It is recommended to have the resistance of the connected motor calibrated by the frequency inverter (P208 / P220).

Motor (IE1) SK …	Frequency inverter SK 5xxE-…	M_N 1) [Nm]	Motor data for parameterisation							
			F_N [Hz]	n_N [min-1]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
63S/4	250-340-	0,90	100	2880	0,95	400	0,25	0,63	Δ	47,37
63L/4	370-340-	1,23	100	2895	1,07	400	0,37	0,71	Δ	39,90
71L/4	550-340-	1,81	100	2900	1,59	400	0,55	0,72	Δ	22,85
80S/4	750-340-	2,46	100	2910	2,0	400	0,75	0,72	Δ	15,79
80L/4	111-340-	3,61	100	2910	2,8	400	1,1	0,74	Δ	10,49
90S/4	151-340-	4,90	100	2925	3,75	400	1,5	0,76	Δ	6,41
90L/4	221-340-	7,19	100	2920	4,96	400	2,2	0,82	Δ	3,99
100L/4	301-340-	9,78	100	2930	6,95	400	3,0	0,78	Δ	2,78
100LA/4	401-340-	12,95	100	2950	7,46	400	4,0	0,76	Δ	1,71
112M/4	551-340-	17,83	100	2945	11,3	400	5,5	0,82	Δ	1,11
132S/4	751-340-	24,24	100	2955	16,0	400	7,5	0,82	Δ	0,72
132MA/4	112-340-	35,49	100	2960	23,0	400	11,0	0,80	Δ	0,39

1) At the rating point

Motor (IE2) SK …	Frequency inverter SK 5xxE-…	M_N 1) [Nm]	Motor data for parameterisation							
			F_N [Hz]	n_N [rpm]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
80SH/4	750-340-	2,44	100	2930	1,9	400	0,75	0,7	Δ	9,34
80LH/4	111-340-	3,60	100	2920	2,56	400	1,1	0,73	Δ	6,3
90SH/4	151-340-	4,89	100	2930	3,53	400	1,5	0,79	Δ	4,96
90LH/4	221-340-	7,18	100	2925	4,98	400	2,2	0,79	Δ	3,27
100LH/4	301-340-	9,69	100	2955	6,47	400	3,0	0,78	Δ	1,73
100AH/4	401-340-	13,0	100	2940	8,24	400	4,0	0,79	Δ	1,48
112MH/4	551-340-	17,8	100	2950	11,13	400	5,5	0,82	Δ	1,0
132SH/4	751-340-	24,2	100	2960	15,3	400	7,5	0,83	Δ	0,6
132MH/4	112-340-	29,6	100	2965	19,5	400	9,2	0,79	Δ	0,42
160MH/4	152-340-	48,3	100	2967	29,0	400	15,0	0,87	Δ	0,256
160LH/4	182-340-	59,4	100	2975	35,7	400	18,5	0,86	Δ	0,168
180MH/4	222-340-	70,5	100	2980	43,2	400	22	0,85	Δ	0,115

1) At the rating point

Motor (IE3) SK …	Frequency inverter SK 5xxE-…	M_N 1) [Nm]	Motor data for parameterisation							
			F_N [Hz]	n_N [min-1]	I_N [A]	U_N [V]	P_N [kW]	cos φ	Y/Δ	R_{St} [Ω]
Notice: A comma counts as a full stop and signifies a decimal place.										
63 SP/4	550-340-	0,59	100	2885	0,58	400	0,18	0,61	Δ	66,7
63 LP/4	550-340-	0,82	100	2910	0,83	400	0,25	0,56	Δ	39,7
71 SP/4	550-340-	1,20	100	2920	1,01	400	0,37	0,69	Δ	24,0
71 LP/4	550-340-	1,79	100	2925	1,34	400	0,55	0,72	Δ	17,7
80 SP/4	750-340-	2,44	100	2935	1,77	400	0,75	0,73	Δ	10,4
80 LP/4	111-340-	3,58	100	2930	2,13	400	1,1	0,84	Δ	6,50
90 SP/4	151-340-	4,86	100	2945	3,1	400	1,5	0,79	Δ	4,16
90 LP/4	221-340-	7,17	100	2930	4,33	400	2,2	0,83	Δ	3,15
100 LP/4 2)	301-340-	9,65	100	2970	5,79	400	3,0	0,82	Δ	1,77
100 AP/4 2)	401-340-	12,9	100	2960	7,52	400	4	0,85	Δ	1,29
112 MP/4	551-340-	17,8	100	2950	10,3	400	5,5	0,85	Δ	0,91
132 SP/4	751-340-	24,1	100	2970	14,3	400	7,5	0,83	Δ	0,503
132 MP/4	112-340-	29,6	100	2970	18	400	9,2	0,82	Δ	0,381
160 SP/4	152-340-	35,3	100	2975	21	400	11	0,85	Δ	0,295
160 MP/4	152-340-	48,2	100	2970	27,5	400	15	0,86	Δ	0,262
160 LP/4	182-340-	59,4	100	2975	34,4	400	18,5	0,85	Δ	0,169
180 MP/4	222-340-	70,4	100	2985	40,6	400	22	0,85	Δ	0,101
180 LP/4	302-340-	96,3	100	2980	54,6	400	30	0,88	Δ	0,098

1) At the rating point

2) APAB series

8.8 Motor data – characteristic curves (synchronous motors)

When operating the motor on a NORDAC frequency inverter, use the motor data listed in the corresponding motor data sheet to parameterise the motor data. The motor data sheet is available from NORD or can be requested from NORD.

For the assignments of the motors to a frequency inverter, refer to 🕮 B5000.

8.9 Scaling of setpoint/actual values

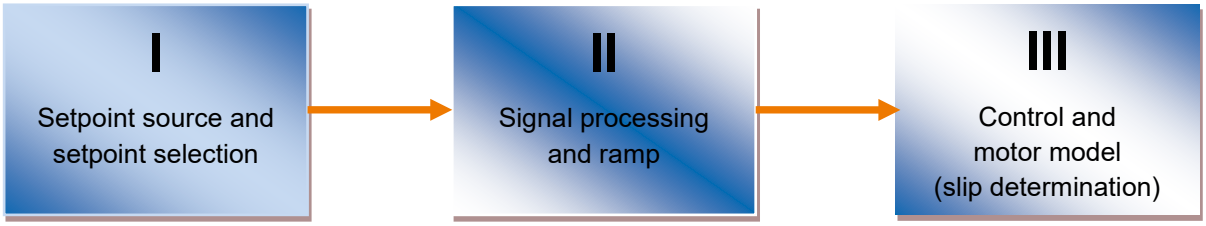
The following table contains details for the scaling of typical setpoint and actual values. These details relate to parameters (P400), (P418), (P543), (P546), (P740) or (P741).

Designation	**Analogue signal**		**Bus signal**						
Setpoints {Function}	Value range	Scaling	Value range	Max. value	Type	100% =	-100% =	Scaling	Limit for abso-lute
Setpoint frequency {01}	0-10V (10V=100%)	P104 … P105 (min - max)	±100%	16384	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * f_{soll}[Hz]/P105	P105
Frequency addition {04}	0-10V (10V=100%)	P410 … P411 (min - max)	±200%	32767	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * f_{soll}[Hz]/P411	P105
Frequency subtraction {05}	0-10V (10V=100%)	P410 … P411 (min - max)	±200%	32767	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * f_{soll}[Hz]/P411	P105
Maximum frequency {07}	0-10V (10V=100%)	P411	±200%	32767	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * f_{soll}[Hz]/P411	P105
Cur.val process ctrl {14}	0-10V (10V=100%)	P105* U_{AIN}(V)/10V	±100%	16384	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * f_{soll}[Hz]/P105	P105
Nom.val process ctrl {15}	0-10V (10V=100%)	P105* U_{AIN}(V)/10V	±100%	16384	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * f_{soll}[Hz]/P105	P105
Torque current limit {2}	0-10V (10V=100%)	P112* U_{AIN}(V)/10V	0-100%	16384	INT	4000_{hex} 16384_{dec}	/	4000_{hex} * Torque [%] / P112	P112
Current limit {6}	0-10V (10V=100%)	P536* U_{AIN}(V)/10V	0-100%	16384	INT	4000_{hex} 16384_{dec}	/	4000_{hex} * Current limit [%] / P536 * 100 [%]	P536
Ramp time {49} Acceleration time {56} Deceleration time {57}	0-10V (10V=100%)	P102 / P103 U_{AIN}(V)/10V	100%	32767	INT	$7FFF_{hex}$ 32767_{dec}	/	P102 / P103 bus setpoint/4000_{hex}	P102 / P105
Actual values {Function}									
Actual frequency {01}	0-10V (10V=100%)	P201* U_{AOut}(V)/10V	±100%	16384	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * f[Hz]/P201	
Actual speed {02}	0-10V (10V=100%)	P202* U_{AOut}(V)/10V	±200%	32767	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * n[rpm]/P202	
Current {03}	0-10V (10V=100%)	P203* U_{AOut}(V)/10V	±200%	32767	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * I[A]/P203	
Torque current {04}	0-10V (10V=100%)	P112* 100/ √((P203)²-(P209)²)* U_{AOut}(V)/10V	±200%	32767	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * I_q[A]/(P112)*100/ √((P203)²-(P209)²)	
Setpoint frequency master value {19} … {24}	0-10V (10V=100%)	P105* U_{AOut}(V)/10V	±100%	16384	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * f[Hz]/P105	
Speed from encoders {22}	/	/	±200%	32767	INT	4000_{hex} 16384_{dec}	$C000_{hex}$ -16385_{dec}	4000_{hex} * n[rpm] / (P201 * 60s / number of pole pairs)	

Table 40: Scaling of set/actual values (selection)

8.10 Definition of set and actual value processing (frequencies)

The frequencies used in P502 / P543 are processed in various ways according to the following table.



Func.	Name	Meaning	Output to ...			Without left/right	With slip
			I	II	III		
8	Set point frequency	Set point frequency from setpoint source	X				
1	Actual frequency	Set point frequency before motor model		X			
23	Act. freq. With slip	Actual frequency on the motor			X		X
19	Freq. Master Value	Set point frequency from setpoint source Master value (freed from enable direction)	X			X	
20	Set Freq. After Ramp	Set point frequency before motor model Master value (freed from enable direction)		X		X	
24	Lead.act.freq.+slip	Actual frequency on the motor Master value (freed from enable direction)			X	X	X
21	Act. Freq. w/o Slip	Actual frequency without slip Master value			X		

Table 41: Set and actual value processing in the frequency inverter

9 Maintenance and servicing information

9.1 Maintenance information

NORD frequency inverters are *maintenance-free* in normal operation(see chapter 7.1 "General frequency inverter data").

Dusty environments

If the device is operated in dusty air, the cooling surfaces must be cleaned with compressed air at regular intervals.

Long-term storage

Information

Climatic conditions for long-term storage

- Temperature: +5 to +35°C
- Relative humidity: < 75%

The device must be connected to the supply network for at least 60 minutes each year. During this time, the device must not be loaded at either the motor or control terminals.

If these steps are not taken, this may result in destruction of the device.

Information

For SK 5x5E devices, a 24 V control voltage supply must be provided for sizes 1 ... 4 in order to make the regeneration process possible.

9.2 Service notes

In case of service/repair, contact your NORD Service contact person. You will find your contact person listed on your order confirmation. Additionally, you will find further possible contact persons using the following link: https://www.nord.com/de/global/locator-tool.jsp.

When contacting our technical support please have the following information available:

- Device type (name plate / display)
- Serial number (name plate)
- Software version (parameter P707)
- Information regarding accessories and options used

If you would like to send the device in for repair please proceed as follows:

- Remove all non-original parts from the device.

  NORD accepts no liability for any attached parts such as power cables, switches or external displays!

- Back up the parameter settings before sending in the device.
- State the reason for sending in the component / device.
  - You can obtain a return note from our web site (Link) or from our technical support.
  - In order to rule out the possibility that the device fault is cause by an optional module, the connected optional modules should also be returned in case of a fault.
- Specify a contact person for possible queries.

Information

Factory settings of parameters

Unless otherwise agreed, the device is reset to the factory settings after inspection/repair.

The manual and additional information can be found on the Internet under www.nord.com.

9.3 Disposal

NORD products are made of high-quality components and valuable materials. Therefore, have faulty or defective appliances checked to see if they can be repaired and reused.

If repair and reuse is not possible, observe the following disposal notes.

9.3.1 Disposal according to German law

- The components are marked with the crossed-out waste bin according to the “Electrical and Electronic Equipment Directive – ElektroG3” (dated 20 May 2021, valid from 1 January 2022).

  The appliances must therefore not be disposed of as unsorted municipal waste, but must be collected separately and handed to a WEEE (Waste of Electrical and Electronic Equipment) registered collection point.

- The components do not contain any electrochemical cells, batteries or accumulators, which must be separated and disposed of separately.
- In Germany, NORD components can be handed in at the headquarters of Getriebebau NORD GmbH & Co. KG.

WEEE Reg. No.	Name of the manufacturer / authorised representative	Category	Appliance type
DE12890892	Getriebebau NORD GmbH & Co. KG	Appliances where at least one of the outer dimensions exceeds 50 cm (large appliances)	Large appliances for exclusive use in other than private households
		Appliances where none of the outer dimensions exceeds 50 cm (small appliances)	Small appliances for exclusive use in other than private households

- Contact: info@nord.com

9.3.2 Disposal outside of Germany

Outside Germany, please contact the local subsidiaries or distributors of the NORD DRIVESYSTEM Group.

9.4 Abbreviations

AI (AIN)	Analog input
AO (AOUT)	Analogue output
BR	Braking resistor
DI (DIN)	Digital input
DO (DOUT)	Digital output
I / O	Input /Output
EEPROM	Non-volatile memory
EMKF	Electromotive force (induction voltage)
EMC	Electromagnetic compatibility
FI-(Switch)	Leakage current circuit breaker
FI	Frequency inverter
I/O	In / Out (Input / Output)
ISD	Field current (Current vector control)
LED	Light-emitting diode
PMSM	Permanent Magnet Synchronous motor (permanently excited synchronous motor)
S	Supervisor Parameter, P003
SH	"Safe stop" function
SW	Software version, P707
TI	Technical information / Data sheet (Data sheet for NORD accessories)

Key word index

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